

Nortronics® Record, Playback, Record/Playback and Erase Heads

THE NORTRONICS COMPANY, INC. 8101 TENTH AVENUE NORTH MINNEAPOLIS, MINNESOTA 55427

The NORTRONICS professional 8000 series of magnetic tape heads are designed to offer highest quality performance and long dependable service. To find the proper Nortronics replacement head for your Ampex, Crown, Magnecord, Tape-A-Thon or R.C.A. professional recorder, see Form No. 7226, "Replacement Heads for Professional Recorders."

These heads have special characteristics and are not to be confused with the Nortronics standard or premium series of heads. See Form No. 7227 for professional series head prices.

■ Record Only, Play Only and Record/Play Heads (See the reverse side of this sheet for Erase Head Data)



8000 Series
Full Track



8200 Series
2-Track Stereo

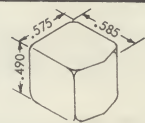


8400 Series
2-Track Mono



8600 Series
4-Track Stereo

All Nortronics professional series record, playback and record/playback heads have the same case dimensions (see figure at right). This allows easy conversion from one track system to another.



SEE THE REVERSE SIDE OF THIS SHEET FOR HEAD MOUNTING INFORMATION

HEAD DESCRIPTION	NORTRONICS MODEL NUMBER (No Mount)	HEAD FUNCTION	INDUCTANCE, 1 KC		IMPEDANCE, 1 KC		RESISTANCE, D.C.		GAP SPACER	TRACK WIDTH	TRACK SPACING Center-to-Center	1 KC CROSSTALK REJECTION	Average 7.5IPS constant-current R/P characteristics, using 3M190 Tape, peak biased at 1 kc and recorded 12 db below tape saturation.					
			MHY.	OHMS.	OHMS.	MILS.	INCH	INCH					DB.	MA.	VOLTS	UA.	MV.	DB.
FULL TRACK Hyperbolic Face Laminated Cores	8000	Play	1000	6000	400	0.16	.260	—	—	—	—	—	—	—	—	7	—	
	8001	Record	10	60	6	0.5	.260	—	—	—	—	—	4.0	15	320	—	—	
	8002	Record	37	230	60	0.16	.260	—	—	—	—	—	1.0	30	100	—	—	
	8003	Play	400	2500	285	0.16	.260	—	—	—	—	—	—	—	—	6	0	
	8004	Record	3.6	24	3	0.5	.260	—	—	—	—	—	1.6	8*	1400	—	—	
	8005	Record	30	190	22	0.5	.260	—	—	—	—	—	1.8	30	180	—	—	
	8006	Record/Play	250	1500	200	0.16	.260	—	—	—	—	—	1.2	40	90	4.0	0	
8007	Record/Play	1.2	8	3.2	0.16	.260	—	—	—	—	—	12.0	5*	800	0.25	0		
2-TRACK STEREO Hyperbolic Metal Face Laminated Cores	8200	Play	800	5000	380	0.16	.080	.160	55	—	—	—	—	—	—	3.5	0	
	8201	Record	10	72	27	0.5	.080	.160	55	1.7	6	200	—	—	—	—	—	
	8202	Play	200	1300	190	0.16	.080	.160	55	—	—	—	—	—	—	—	—	
	8203	Record	30	200	72	0.5	.080	.160	55	0.9	15	100	—	—	—	—	—	
	8204	Record	50	320	130	0.5	.080	.160	55	0.7	18	75	—	—	—	—	—	
	8205	Play	400	2500	250	0.1	.080	.160	55	—	—	—	—	—	—	2.1	0	
	8206	Record	3.7	25	16	0.5	.080	.160	55	4.3	5.5*	250	—	—	—	—	—	
	8207	Record/Play	1.2	7.5	1.5	0.1	.080	.160	55	7	2.0*	800	0.4	—	—	—	—	
	8208	Play	450	3300	410	0.05	.080	.160	55	—	—	—	—	—	—	2.2	+2	
	8209	Record/Play	400	2500	410	0.1	.080	.160	55	0.33	60	40	2.4	+2	—	—	—	
8214	Record	2.0	15	5.5	0.5	.080	.160	55	5.0	3.5	250	—	—	—	—	—		
2-TRACK MONO Hyperbolic Metal Face Laminated Cores	8400	Play	800	5000	380	0.16	.080	—	—	—	—	—	—	—	—	3.5	—	
	8401	Record	10	75	14	0.5	.080	—	—	—	—	—	1.7	6	200	—	—	
	8402	Play	20	150	—	0.1	.080	—	—	—	—	—	—	—	—	0.5	0	
	8403	Record/Play	400	2500	165	0.1	.080	—	—	—	—	—	0.33	60	40	2.4	+1	
	8404	Record	50	320	70	0.5	.080	—	—	—	—	—	0.7	18	75	—	—	
	8405	Play	400	2500	165	0.1	.080	—	—	—	—	—	—	—	—	2.2	-1	
	8406	Play	500	3300	165	0.05	.080	—	—	—	—	—	—	—	—	2.2	+3	
	8407	Play	1.2	7.5	—	0.1	.080	—	—	—	—	—	7	2.0*	800	0.1	—	
	8408	Record/Play	200	1300	110	0.1	.080	—	—	—	—	—	0.4	30	60	1.8	+1	
	8414	Record	2.0	15	5.5	0.5	.080	—	—	—	—	—	5.0	3.5	250	—	—	
4-TRACK STEREO Hyperbolic Metal Face Laminated Cores	8600	Play	800	5000	700	0.1	.043	.136	55	—	—	—	—	—	—	2.6	+1	
	8601	Play	500	3300	390	0.05	.043	.136	55	—	—	—	—	—	—	1.8	+2	
	8602	Record	30	200	60	0.5	.043	.136	55	0.80	12	78	—	—	—	—	—	
	8603	Record	50	400	260	0.5	.043	.136	55	0.65	15	60	—	—	—	—	—	
	8604	Record	10	70	32	0.5	.043	.136	55	1.3	60	140	—	—	—	—	—	
	8607	Record/Play	200	1300	200	0.1	.043	.136	55	0.4	40	50	1.3	+1	—	—	—	
	8608	Record/Play	400	2500	390	0.1	.043	.136	55	0.25	60	35	1.8	+1	—	—	—	
	8614	Record	2.0	15	6.0	0.5	.043	.136	55	3.8	2.5	250	—	—	—	—	—	

*80 KC

Specifications subject to change without notice.

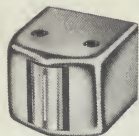
YOUR LOCAL DEALER

HYPERBOLIC FACE

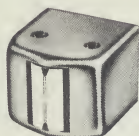


Incorporated on all professional series heads. Gives intimate tape-to-gap contact without need for pressure pads, but is designed to allow use with pressure pads as well.

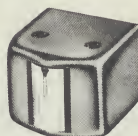
■ **Erase Heads** (SEE THE REVERSE SIDE OF THIS SHEET FOR RECORD, PLAYBACK, AND RECORD/PLAYBACK HEAD DATA)



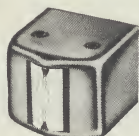
8100 SERIES
Full Track



8300 SERIES
2-Track Stereo

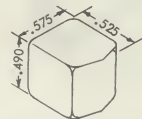


8500 SERIES
2-Track Mono



8700 SERIES
4-Track Stereo

All Nortronics professional series erase heads have the same case dimensions (see figure at right). This allows easy conversion from one track system to another.



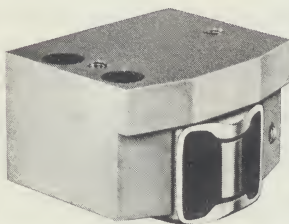
HEAD DESCRIPTION	NORTRONICS MODEL NUMBER NO MOUNT	INDUCTANCE, 1 KC	IMPEDANCE, 60 KC	RESISTANCE, D.C.	OPERATING VOLTAGE 60 KC, RMS	OPERATING VOLTAGE 100 KC, RMS	ERASE CURRENT OPERATING
		MHY	OHMS	OHMS	VOLT	VOLT	MA
FULL TRACK Full Metal Face	8101	40	12.000	88	100-150	160-200	10-15
	8102	0.085	24	1.3	6-9	10-14	250-350
	8104	3.6	1.000	25	32-48	50-70	32-48
	8105	0.6	250*	4	15-22*	20-30	80-100
	8106	6	1.800	30	—	75-95	30-40
	8109	2.6	600*	20	25-35	43-57	42-57
	8110	2.6	600*	20	35-46*	—	42-52
2-TRACK STEREO Full Metal Face	8301	50	20.000	205	100-150	160-200	4.5-7.0
	8302	0.2	50	2	5-8	8-15	100-150
	8304	8	2.000	35	32-48	50-70	16-24
	8306	0.7	250*	3.6	15-22*	20-30	40-70
	8307	8	2.000	35	40-55*	—	16-24
	8501	50	20.000	205	100-150	160-200	4.5-7.0
2-TRACK MONO Full Metal Face	8502	0.2	50	2	5-8	8-15	100-150
	8504	8	2.000	35	32-48	50-70	16-24
	8506	0.7	250*	3.6	15-22*	20-30	40-70
	8701	10	2.800	40	28-42	45-60	10-15
4-TRACK STEREO Full Metal Face	8702	0.13	40	2	3-6	5-12	80-140
	8704	80	30.000	270	90-150	150-200	3-5
	8708	2.0	500*	6	15-25*	20-30	30-50

† For 56 DB erasure of saturated tape.

*80 KC.

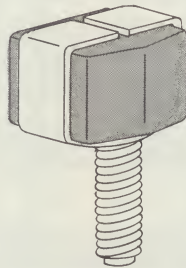
Specifications subject to change without notice.

■ **Head Mounting Brackets for Professional Machines**

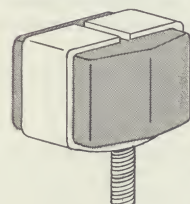


QK-76 WITH NORTRONICS HEAD MOUNTED IN PLACE

QK-35 is a special base-mount bracket kit for adapting Nortronics no-mount heads for replacement of Brush Heads or in any application requiring a large base mounting stud. (Stud—1/4-28 X 5/8).

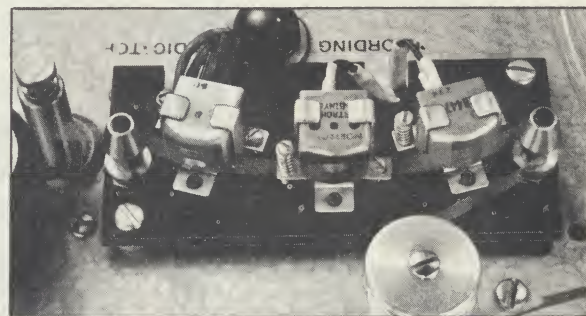


QK-35 MOUNTED ON NORTRONICS HEAD



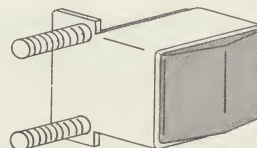
QK-66 MOUNTED ON NORTRONICS HEAD

QK-66 is a standard base-mount bracket kit for adapting Nortronics no-mount heads for most base-mount applications. (Stud—6-32 X 5/16).



QK-81 WITH 3 NORTRONICS HEADS MOUNTED IN PLACE ON MAGNECORD PT6 MACHINE

QK-81 is a completely assembled kit which allows conversion of the MagneCORD PT6 and PT63 type machines to modern heads. The third head position can be used for monitor or stereo playback. Instructions are included to adapt the original MagneCORD electronics to accept the new Nortronics heads and meet NAB standards on equalization. Response to 15 KC at 7.5 IPS and 10 KC at 3.75 IPS. Write for Form No. 7242 for description of the QK-81 and recommended heads.



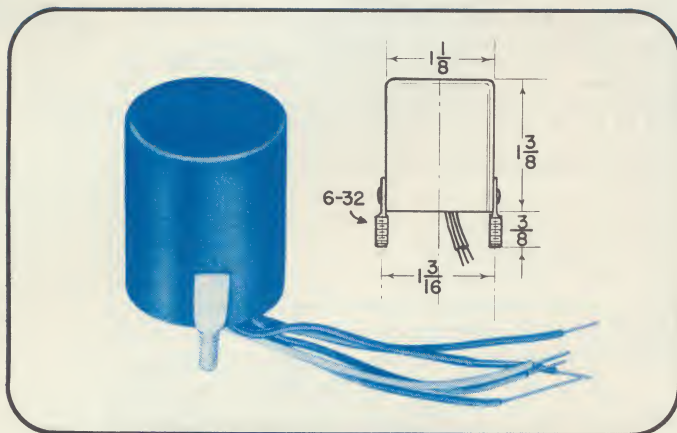
QK-38 MOUNTED ON NORTRONICS HEAD

QK-38 is a standard side-mount bracket kit for adapting Nortronics no-mount heads for most side-mount applications.



Nortronics BIAS AND ERASE OSCILLATOR TRANSFORMERS FOR TRANSISTOR AND VACUUM TUBE CIRCUIT USE

THE NORTRONICS COMPANY, INC. 8101 TENTH AVENUE NORTH MINNEAPOLIS, MINNESOTA 55427



T60 SERIES TRANSFORMERS

- FERRITE E-CORE CONSTRUCTION
- GOOD REGULATION
- HIGH EFFICIENCY, HIGH Q
- WIDE FREQUENCY RANGE
- WIDE VOLTAGE RANGE

Model T60-T2 is designed primarily for use with transistors. Models T60-E and T60-F are designed for medium frequency and high frequency vacuum tube use respectively. All T60 series transformers make use of ferrite E-core construction. The outstanding performance characteristics of the T60 units will insure low tape noise on erasure and low distortion during the recording process.

THE T60-T2 TRANSISTOR TRANSFORMER

TABLE 1

Lead Color Secondary Tap	Nominal Load Impedance	Max. Load Current Total	Voltage Under Load
Green	1.5K	35-45MA	30-40V
Yellow	6K	18-25MA	60-80V
Brown	13.5K	12-16MA	90-120V

Push-Pull Data
with Supply Volt
18-25VDC

PRI-L-0.13MH
PRI-DCR 0.40 OHMS

THE PUSH-PULL BIAS OSCILLATOR. The included schematic shows the T60-T2 used as a push-pull oscillator. This is a somewhat preferred method of operation; the greater power reserve, improved regulation, and reduced even-harmonic generation will provide a fully professional oscillator unit for the most critical applications. By making use of the data given in table 2 the designer can adapt the push-pull circuit for either high or low impedance heads at 60 kc and also low impedance heads at 60, 80, or 100 kc.

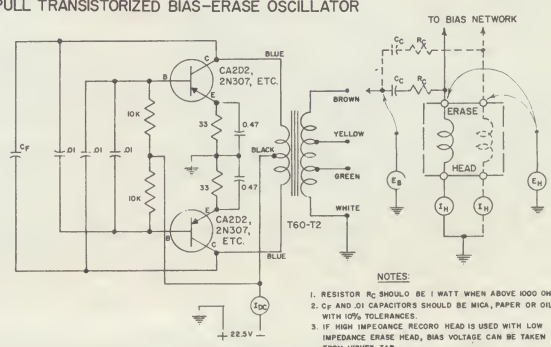
While the values shown in the table are only center-values, they will be within normal tolerances depending upon the components used, etc. For monaural use, the designer simply uses one section of the output as shown. The MEF4 being a full track head is, of course, a monaural head.

TRANSISTORS. Inexpensive transistors such as the Honeywell CA2D2, the Sylvania 2N307, etc., will provide performance well within transistor ratings when the supply voltage is between 18 and 25 volts. When it is desirable to make use of better temperature stabilization characteristics, silicon transistors such as the RCA 2N2270 or the Honeywell 2N1987 can be used.

OUTPUT VOLTAGES. The output voltage available is a function of the chosen frequency as well as the supply voltage to be used. Table 1 and table 2 can be used to determine what taps and head impedances should be used to best meet the design requirements. The supply voltage which has been chosen as 22.5 volts for table 2 data can be reduced to a value as low as 12 volts under some conditions. The designer will find it necessary to adjust bias resistors and other parameter sizes when operating at such a low voltage to insure proper erase head power.

OPERATING FREQUENCY. The frequency of the oscillator can be altered by the use of capacitor C_f . The reflected inductance of the load in combination with the primary inductance of the transformer in cooperation with C_f predominantly determines the operating frequency of the oscillator. In some cases the amplifier designer will find it desirable to resonate the output of the oscillator with a series capacitor C_c feeding the erase head (or heads). Under these conditions the erase head inductance and C_c will offer a purely resistive load to the secondary (and primary) of the transformer and therefore the oscillating frequency will essentially be determined by the resistive loaded, primary inductance of the transformer circuit alone. More about the use of resonant coupling will be given later.

PUSH-PULL TRANSISTORIZED BIAS-ERASE OSCILLATOR



SINGLE-ENDED OSCILLATOR. The single-ended oscillator shown in the other included schematic is for specific operation at 60 kc; the frequency can be varied again by changing the value of C_f . The single-ended circuit will provide adequate performance for many applications. While it is possible to obtain better regulation and more power with the push-pull unit, circuit parts economy and space requirements will often dictate use of the single unit. Resistor R_b determines the operating bias of the transistor and will determine the output power available from the oscillator within a moderate range of adjustment. Care must be taken with this adjustment to avoid exceeding the operating ranges of the transistor.

ERASE HEAD COUPLING. As discussed briefly above, erase heads should be coupled to the secondary of the bias transformer in the manner shown in the push-pull schematic. When capacitor C_c is chosen to series resonate with the erase head at the operating frequency, there will be an increase in voltage noted across the erase head proper. The value of this voltage is approximately equal to the output voltage of the secondary times the operating Q of the erase head (for Nortronics erase heads, the resonant voltage is between 10% and 30% higher than the secondary voltage; this is shown in table 2 where C_c is chosen to be resonant with the head). This action of resonance also provides a small amount of filtering and thus can be used to enhance the waveform applied to the bias network. It should be pointed out that if the designer chooses a capacitor C_c larger than the resonant value, the degeneration in output waveform across the head will be negligible. The use of a variable pad capacitor for C_c will permit exact resonant tuning if desired.

SINGLE-ENDED TRANSISTORIZED BIAS-ERASE OSCILLATOR

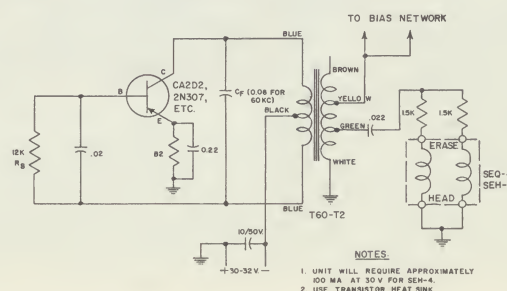


TABLE 2 T60-T2

F	HEAD TYPE	C _F MFD	C _C MMFD	R _C OHMS	TAP	I _{DC} (MA)	E _{DC}	E _S (AC)	E _H (AC)	I _H /SECT (MA)
60kc	SEQ-4	.055	1500	1000	G	140	22.5	38	46	14
60kc	SEH-4	.055	1500	120	G	190	22.5	33	48	22
60kc	SEQ-1	.055	150	1000	B	170	22.5	110	125	6
60kc	SEH-1	.055	240	330	B	170	22.5	110	125	7
80kc	SEQ-4	.03	650	47	G	140	22.5	40	60	14
80kc	SEH-4	.03	1500	0	G	160	22.5	36	50	22
100kc	SEQ-4	.02	650	0	Y	200	22.5	36	60	14
100kc	SEH-4	.02	650	0	G	175	22.5	40	52	22
60kc	MEF-4	.055	1500	0	G	150	22.5	40	45	40

Along with suggested values for parameters, table 2 gives center-value operating currents and voltages that will result with four basic popular Nortronics erase heads. This data was taken with short unshielded leads coupling the oscillator to the heads. If it is necessary to use shielded leads or even long unshielded leads, it may be necessary to alter some of the capacitor and resistor sizes.

THE T60-E TRANSFORMER

THE PUSH-PULL BIAS OSCILLATOR. The included schematic shows the T60-E used as a push-pull oscillator. This unit will provide a fully professional oscillator unit for the most critical applications. By making use of the data given in table 3 the designer can adapt the push-pull circuit for high impedance heads at 40, 50, 60 or 70 kc. A low impedance winding will provide power to several low impedance heads as shown in the dashed schematic addition.

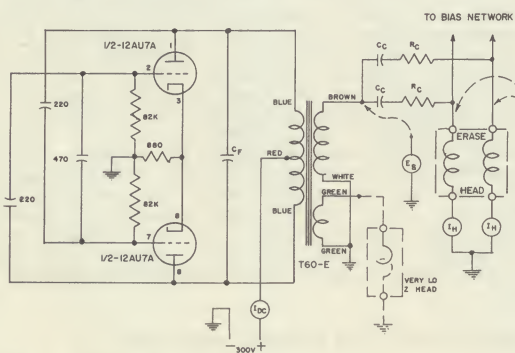
While the values shown in the table are only center-values, they will be within normal tolerances depending upon the components used, etc. For monaural use, the designer simply uses one section of the output as shown. The MEF1 being a full track head is, of course, a monaural head.

VACUUM TUBES. Vacuum tubes such as 12AU7A will provide performance well within dissipation ratings of the tubes when the supply voltage is under 300 volts. A tube such as the 12BH7 can supply slightly more erase power in special circuits.

OUTPUT VOLTAGES. The output voltage available is a function of the chosen frequency as well as the supply voltage to be used. The supply voltage which has been chosen as 300 volts for table 3 data can be reduced to a value as low as 150 volts under some conditions. The designer will find it necessary to adjust bias resistors and other parameter sizes when operating at such a low voltage to insure proper erase head power.

OPERATING FREQUENCY. The frequency of the oscillator can be altered by the use of capacitor C_F. The reflected inductance of the load in combination with the primary inductance of the transformer in cooperation with C_F predominantly determines the operating frequency of the oscillator. In some cases the amplifier designer will find it desirable to resonate the output of the oscillator with a series capacitor C_C feeding the erase head (or heads). Under these conditions the erase head inductance and C_C will offer a purely resistive load to the secondary (and primary) of the transformer and therefore the oscillating frequency will essentially be determined by the resistive loaded, primary inductance of the transformer circuit alone. More about the use of resonant coupling will be given later.

40KC TO 70KC BIAS-ERASE OSCILLATOR USING T60-E



ERASE HEAD COUPLING. As discussed briefly above, erase heads should be coupled to the secondary of the bias transformer in the manner shown in the push-pull schematic. When capacitor C_C is chosen to series resonate with the erase head at the operating frequency, there will be an increase in voltage noted across the erase head proper. The value of this voltage of the secondary times the operating Q of the erase head (for Nortronics erase heads, the resonant voltage is between 10% and 30% higher than the secondary voltage; this is shown in table 3 where C_C is chosen to be resonant with the head). This action of resonance also provides a small amount of filtering and thus can be used to enhance the waveform applied to the bias network.

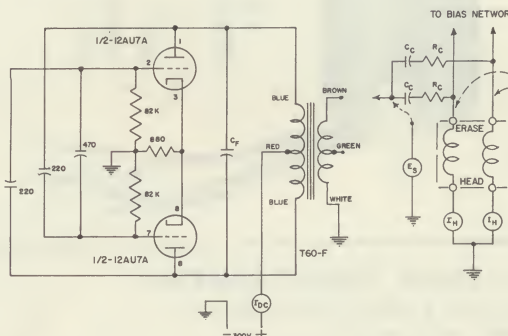
TABLE 3 T60-E

F	HEAD TYPE	C _F MMFD	C _C MMFD	R _C OHMS	TAP	I _{DC} (MA)	E _{DC}	E _S (AC)	E _H (AC)	I _H /SECT (MA)
40kc	SEQ-1	330	470	10k	B	10	300	120	120	6
50kc	SEQ-1	150	220	8.2k	B	9	300	125	140	6
60kc	SEQ-1	68	120	6.8k	B	8	300	125	135	6
70kc	SEQ-1	0	100	2.2k	B	7.5	300	125	140	6
40kc	SEH-1	330	470	3.9k	B	10	300	115	115	7
50kc	SEH-1	150	220	2.2k	B	8	300	130	125	7
60kc	SEH-1	47	120	2.2k	B	9	300	120	135	7
70kc	SEH-1	0	100	1k	B	9	300	120	132	7

THE T60-F TRANSFORMER

THE PUSH-PULL BIAS OSCILLATOR. The included schematic shows the T60-F used as a push-pull oscillator. This unit will provide a fully professional oscillator unit for the most critical applications. By making use of the data given in Table 4 the designer can adapt the push-pull circuit for high impedance heads at 70 kc and low impedance heads at 80, 90, and 100 kc.

70KC TO 100KC BIAS-ERASE OSCILLATOR USING T60-F



VACUUM TUBES. Vacuum tubes such as 12AU7A, 12AV7, or the 12AT7, will provide performance well within dissipation ratings of the tubes when the supply voltage is under 300 volts. A tube such as the 12BH7 can supply slightly more erase power in special circuits.

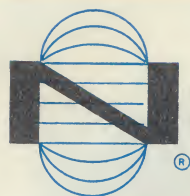
OUTPUT VOLTAGES. The output voltage available is a function of the chosen frequency as well as the supply voltage to be used. The supply voltage which has been chosen as 300 volts for Table 4 data can be reduced to a value as low as 150 volts under some conditions. The designer will find it necessary to adjust bias resistors and other parameter sizes when operating at such a low voltage to insure proper erase head power.

OPERATING FREQUENCY. The frequency of the oscillator can be altered by the use of capacitor C_F. The reflected inductance of the load in combination with the primary inductance of the transformer in cooperation with C_F predominantly determines the operating frequency of the oscillator. In some cases the amplifier designer will find it desirable to resonate the output of the oscillator with a series capacitor C_C feeding the erase head (or heads). Under these conditions the erase head inductance and C_C will offer a purely resistive load to the secondary (and primary) of the transformer

TABLE 4 T60-F

F	HEAD TYPE	C _F MMFD	C _C MMFD	R _C OHMS	TAP	I _{DC} (MA)	E _{DC}	E _S (AC)	E _H (AC)	I _H /SECT (MA)
70kc	SEQ-1	200	100	3.9k	B	12	300	150	160	6
80kc	SEQ-4	125	1000	1.5k	G	11	300	52	58	15
90kc	SEQ-4	47	470	1.5K	G	11	300	58	62	15
100kc	SEQ-4	0	470	1.5K	G	10	300	60	70	15
70kc	SEH-1	200	100	1k	B	13	300	140	150	7
80kc	SEH-4	125	1000	470	G	13	300	48	55	22
90kc	SEH-4	47	1000	470	G	12	300	49	59	22
100kc	SEH-4	0	470	470	G	11	300	50	60	22
70kc	MEF-4	200	1000	220	G	11	300	50	55	45

ERASE HEAD COUPLING. As discussed briefly above, erase heads should be coupled to the secondary of the bias transformer in the manner shown in the push-pull schematic. When capacitor C_C is chosen to series resonate with the erase head at the operating frequency, there will be an increase in voltage noted across the erase head proper. The value of this voltage is approximately equal to the output voltage of the secondary times the operating Q of the erase head (for Nortronics erase heads, the resonant voltage is between 10% and 30% higher than the secondary voltage; this is shown in Table 4 where C_C is chosen to be resonant with the head). This action of resonance also provides a small amount of filtering and thus can be used to enhance the wave form applied to the bias network.



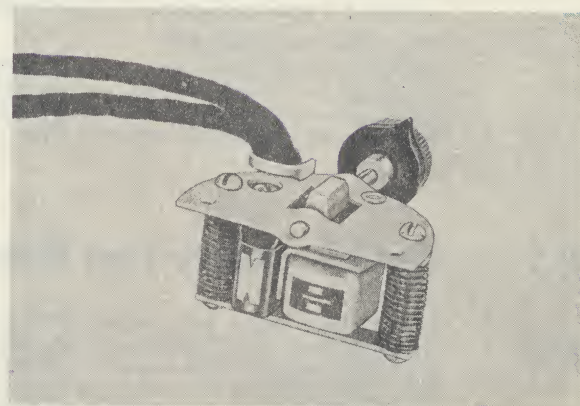
Nortronics® QUALITY 4-TRACK STEREO CONVERSION KITS

THE NORTRONICS COMPANY, INC. 8101 TENTH AVENUE NORTH MINNEAPOLIS, MINNESOTA 55427

WR-60 Converts All Wollensak and Later Revere Monophonic and 2-Track Stereo Recorders to 4-Track Stereo

The WR-60 is a 4-Track Stereo Conversion Kit of advanced design consisting of a 4-track stereo record/play head and a 4-track stereo erase head mounted in a head shifting mechanism. Rotation of the shifter control knob provides three vertical positions of the head assembly, permitting playback of both 2 and 4-track pre-recorded tapes and recording of 4 monophonic tracks on a single tape. Also, sound with sound recordings may be made with a single recorder. Stereo recording with the WR-60 is possible by using an additional recording amplifier such as the Nortronics RA-100.

The WR-60 is supplied completely wired and assembled for ready installation in the tape recorder. The conversion can be performed by a reasonably skilled person with a set of hand tools, including a soldering iron, or by a service shop.

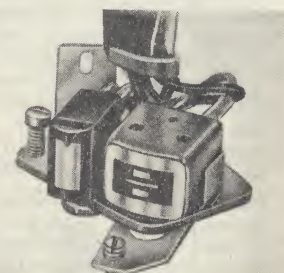


Complete assembly of Nortronics 4-track stereo R/P and erase heads

WR-40 Converts All Wollensak and Later Revere Monophonic Tape Recorders to 4-Track Stereo Playback

Direct replacement of the present monophonic head assembly by the stereo unit of the WR-40 Kit converts the tape recorder to 4-track stereo playback. Monophonic record/playback capabilities are retained. The stereo head is a first-line, fine gap record/play tape head. It will provide unsurpassed high-fidelity playback of pre-recorded 4-track tapes.

The stereo record head and monophonic erase head are mounted on a brass plate, and include connecting cables. The second sound channel is brought out through a miniature phone jack. A patch cord is furnished to make connection to an external audio amplifier.



View showing the stereo head assembly of the WR-40 Kit properly positioned in the head cup of the recorder.

V-6 Stereo Conversion Kits for All 700 Series VM Tape Recorders

V-7

THE NORTRONICS CO., INC. offers first-line 4-track (quarter-track) stereo heads in convenient conversion kits for V-M recorders. Superior high frequency response and reduced hum pickup are features of these heads, which have professional type laminated cores. All V-M Recorders may be converted to 4-track stereo playback with the V-6 kit. In all cases, the original monophonic record/playback capabilities are retained. All V-M Recorders may be converted to 4-track stereo erase/record/playback with the V-6 kit, plus the V-7 erase kit, plus an external recording amplifier, such as the Nortronics RA-100.

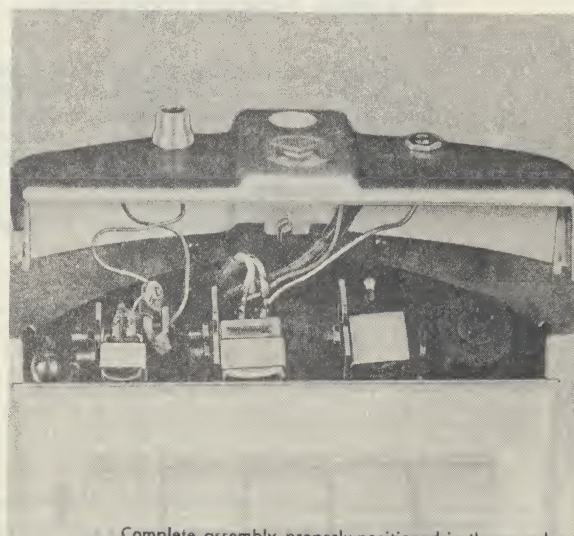
V-6 Conversion Kit.

Converts all V-M machines to 4-track stereo playback. Retains the present two-channel monophonic recording and playback facilities by using present monophonic half-track erase head. Stereo erase for stereo recording requires the V-7 erase conversion kit listed below.

V-7 Erase Conversion Kit.

Replaces monophonic erase head with 4-track erase head to permit stereo recording. To be used in conjunction with the V-6 Kit described above.

The combined V-6 and V-7 conversion kits may be used for both stereo and monophonic four-track recording with the assistance of an external recording amplifier, such as the Nortronics RA-100.



Complete assembly properly positioned in the recorder.

P-6 Converts Pentron Tape Recorders to 4-Track Stereo

P-7

The NORTRONICS CO., INC. supplies its first-line 4-track (quarter-track) stereo heads in convenient conversion kits for Pentron recorders. Superior high frequency response and reduced hum pickup are features of the Nortronics heads, which have professional type laminated cores.

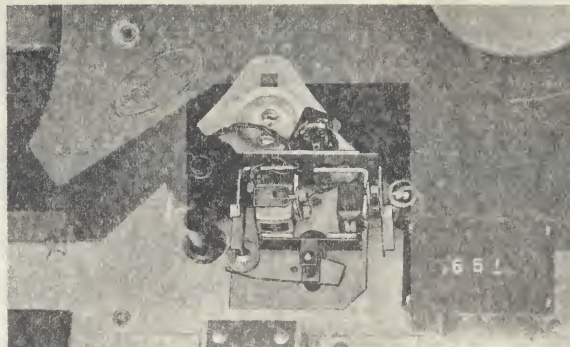
All Monophonic and 2-Track Stereo Pentron recorders may be converted to 4-track stereo playback with the P-6 kit. The ability to record and play back monophonic material is retained.

P-6 Conversion Kit.

Converts the Pentron to 4-track stereo playback. Retains the present two-channel monophonic recording and playback facilities by using present monophonic half-track erase head. Stereo erase with stereo recording requires P-7 erase conversion kit listed below.

P-7 Erase Conversion Kit.

Use the P-7 Erase Conversion Kit on all Pentron recorders except the XP-60, XP-60S, and the NL-4. For the latter machines order the Nortronics 4-track stereo erase head, low impedance, *side mounting* style.



Typical installation showing the Nortronics 4-track stereo R/P head (from P6 kit) in place of the previous monophonic head. The erase head at the right is the Nortronics 4-track stereo erase head from the P-7 kit, and replaces the previous monophonic erase head for stereo recording. If stereo recording is not required only the record head is replaced, and the present monophonic erase head is retained.

W-2 Converts Webcor Tape Recorders to 4-Track Stereo

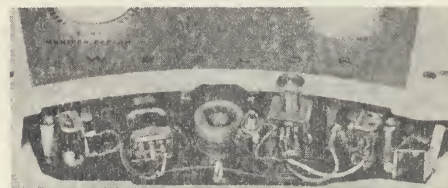
W-6

The W-6 Conversion Kit converts all Monophonic* and Stereo Webcor Tape Recorders in the older 2800, 2900, and 2000 (except 2020) series to 4-Track Stereo playback while retaining all existing monophonic record and playback facilities. A convenient head shifter allows the 4-Track head to be positioned readily for both 2-Track and 4-Track tapes. The NORTRONICS 4-track record/play head has laminated cores for superior high frequency response and long wear life. Completely assembled and ready to install.

*Monophonic machines need a phone jack and patch cord set to bring out the second stereo channel to an external tape playback amplifier. The Nortronics Model PC-100 is recommended. It includes a miniature shorting-type phone jack and a 24-inch patch cord with miniature phone plug on one end and phono plug on other end.

The W-2 Conversion Kit converts all Webcor Tape Recorders in the older 210, 2020, 2100, 2600 and 2700 series to 4-Track Stereo Playback.

The W-2 Conversion Kit consists of a high quality 4-track stereo playback head and bracket assembly which may be used to replace the monophonic head assembly in the above series of Webcor tape recorders.



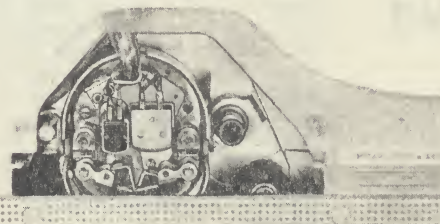
View showing the W-6 Conversion Kit installed on a Webcor two-direction recorder. The present monophonic erase head is left in place.



W-2 installed in place of the right hand head assembly on a two-direction Model 2130 tape recorder.

WR-35 Converts Wollensak and Revere Recorders from 2-Track Stereo to 4-Track Stereo Playback

This 4-track conversion kit contains a high quality 4-track stereo record/play head with laminated cores and extra fine gap for superior high frequency response. This head may be readily installed to replace the present 2-track stereo head in your Revere or Wollensak tape recorder. The original monophonic record/playback capabilities are retained. A head shifter is provided to permit the older 2-track stereo tapes to be played as well as the new 4-track tapes.



Top view of head nest, showing new 4-track stereo head mounted to right of present erase head.

YOUR LOCAL DEALER:



Nortronics®

CUSTOMER ENGINEERING BULLETIN

THE NORTRONICS COMPANY, INC. 8101 TENTH AVENUE NORTH MINNEAPOLIS, MINNESOTA 55427

3.75 INCH PER SECOND TAPE OPERATION

7.5 IPS PERFORMANCE

At the present time a speed of 7.5 IPS will provide excellent performance in a well designed tape recorder. Frequency response can be extended beyond 15 kilocycles with comparative ease and if care is taken to insure good tape guiding and head-to-tape contact, track widths as small as 0.043", such as used on the standard quarter-track system, will provide usable dynamic range up to 50 db. It is true that 15 IPS is used for most master tape recordings, but this is to insure a minimum fidelity loss when rerecording masters for duplication.

3.75 IPS PERFORMANCE

The Nortronics Company is often asked how 3.75 IPS performance compares with 7.5 IPS. This is difficult to evaluate because several factors enter into the picture. Frequency response, usable dynamic range (signal-to-noise ratio without excessive distortion), distortion and effects of high frequency erasure are all important and related. The following paragraphs will explain some of the factors necessary to design a good 3.75 IPS tape system.

With a given tape, record/play head, handler and amplifier, it is necessary to compromise performance when speed is reduced. Frequency response can be partially retained by using reduced bias and by altering the playback and/or record equalization of the amplifier. Dynamic range can be partially retained by not reducing the bias.

It is apparent, then, that a conflict exists which will require the designer to compromise by making only a modest bias reduction and accepting the reduced dynamic range.

DESIGN FACTORS IN SPEED REDUCTION FROM 7.5 TO 3.75 IPS

The heavy solid curve in Figure 2-1 illustrates constant current at reference level, unequaled record/playback response for the new Nortronics B2Q type quarter-track heads at 7.5 IPS at peak bias (peak bias is the bias current that will give a maximum 1 kc signal at reference recording current level, which is appropriately 12 db. below tape saturation at 1 kc.).

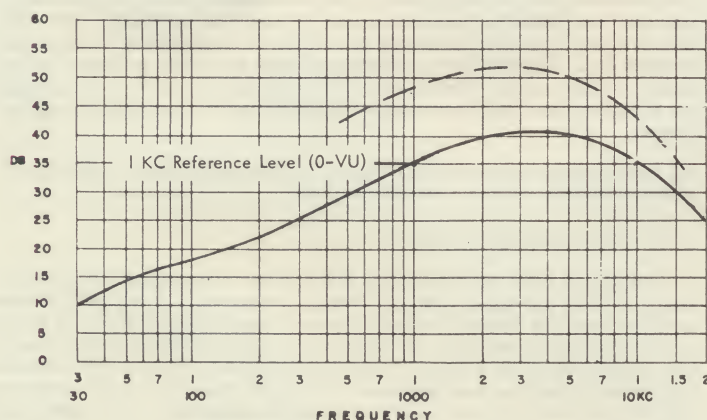


FIGURE 2-1 Constant current record, unequaled playback at a level 12 db below tape saturation at peak bias for 1 kc at 7.5 inches per second. The dashed curve is the tape recording level (just below tape saturation). Distortion at reference level at 1 kc is approximately 2 percent. In many cases, reference level or "0-VU" level is determined at a specific distortion level such as 2 percent.

The light curve in Figure 2-1 is the level just below tape saturation. This means that 12 db. more output can be obtained at 1 kc., 10 db. more at 10 kc., 7 db. more at 15 kc., etc. Figure 2-2 shows the same type of curves for 3.75 IPS at the 3.75 peak bias figure. It is interesting to note that the reserve at 10 kc. has now fallen to only 3 db.

Examining Figure 2-1 more closely on 7.5 IPS operation will bring this information to light: The maximum recording current at 1 kc. is 12 db. above reference level. The maximum record current at 15 kc. is about 7 db. above reference level. Therefore, the maximum current at 15 kc. is approximately 12 minus 7, or 5 db. lower than the maximum recording current at 1 kc. Similarly, referring to Figure 2-2 at 3.75 IPS will show that the maximum recording current at 1 kc. is 12 db. higher than reference level and the maximum recording current at 10 kc. is 3 db. above reference level. Therefore the 10 kc. maximum recording current must be 12 minus 3, or 9 db. lower than the maximum recording current at 1 kc.

This data can be used to show how the recording level at 7.5 IPS is limited to about 8 db. below reference level to obtain flat response to 15 kc. and at 3.75 IPS to about 11 db. below reference level to obtain flat response to 10 kc. Figure 2-3 shows the NAB type, 7.5 IPS playback curve already discussed (Figure 2-1), the resulting recording curve of Figure 2-4 will be needed to produce flat system response to 15 kc. Examining Figure 2-4 reveals that a boost of approximately 15 db. is needed at 15 kc. relative to the 1 kc. level.

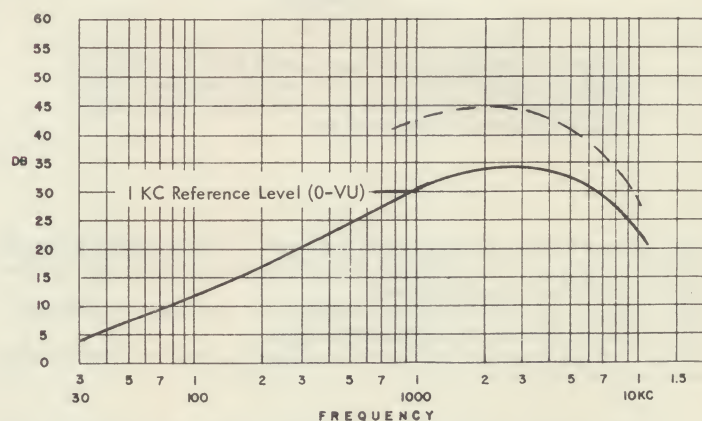


FIGURE 2-2 Constant current record, unequaled playback at 12 db below saturation at peak bias for 1 kc at 3.75 inches per second. Light (dashed) curve is just below tape saturation.

Then, since Figure 2-1 indicated a reserve of only 7 db. exists at 15 kc. when reference level record current is used, it follows that the operating level of the system must be reduced to 15 minus 7, or 8 db. below reference level if flat response to 15 kc. is desired. This will explain why recorder frequency response curves must be run at a level well below "0 VU" to obtain full performance.

At 3.75 IPS the constant current curve of Figure 2-2 indicates a decrease in response at 10 kc. relative to 1 kc. of about 10 db. (in contrast to the equal response of 1 kc. and 10 kc. for 7.5 IPS - Figure 2-1). This additional response drop can be made up by increasing the playback curve (Figure 2-3 dashed curve), by 6 db. at 10 kc. and the record curve (Figure 2-4 dashed curve), by 4 db. As seen in Figure 2-4, an approximate 14 db. boost is necessary at 10 kc. relative to 1 kc. and with a reserve of only 3 db. at 10 kc., it will be necessary to limit the operating level to 14 minus 3 equals 11 db. below reference level if a flat response to 10 kc. is desired.

In summing up, the 7.5 IPS system can provide flat response to 15 kc. at approximately 8 db. below reference level. The 3.75 IPS system can provide flat response to 10 kc. at about 11 db. below reference level. This is graphically illustrated in Figure 2-5. The designer must be fully aware that this simplified technical discussion does not take into account the wide variations that will be caused by tape quality, head alignment, tape-head contact, etc.

A music recording session where an unusual amount of high-level, high-frequency audio energy is generated can severely overload even a 7.5 IPS system unless the recording level is appropriately monitored. At 3.75 IPS it is, of course, more critical. If the level is not lowered, the frequencies in the upper range that overlap into saturation will simultaneously erase the lower frequencies and produce severe distortion. Fortunately, a large percentage of music does not make such demands on a recording system and therefore 3.75 IPS operation will usually give good performance for audiophile and home use as well as in background music and other commercial uses.

One interest point should be brought up: Most non-professional machines have a base noise level limited by amplifier noise or inadequate auxiliary shielding. Thus, it is often possible to enhance signal-to-noise ratio of a recorder at both 3.75 and 7.5 IPS by simply improving the amplifiers and head shielding. In the case of a professional, high-quality recorder where the base noise level is from the tape, it will be necessary to await further tape oxide developments in order to improve dynamic range characteristics.

In review, the following steps are recommended to obtain good performance at 3.75 IPS with Nortronics quarter-track, 100 micro-inch record/play heads.

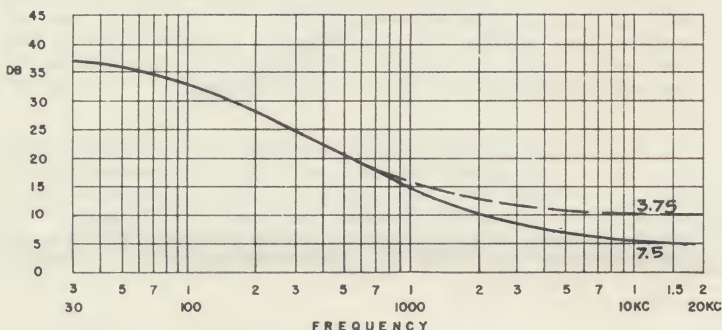


FIGURE 2-3 Playback amplifier response for 7.5 and 3.75 inches per second tape speeds. The 7.5 ips curve is the NAB response. It is almost universally used for playback at 15 and 7.5 ips. There is no official standard for 3.75 and 1.875 ips.

- (1). Reduce the bias current to the 3.75 peak. This is approximately 80 to 85% of the peak 7.5 IPS bias as given on the individual specification sheet for the head type being used.
- (2). Reduce the record current to about 80 to 85% of the 7.5 IPS reference level as given in the specification sheet.
- (3). Alter the playback and record amplifier response as shown in Figure 2-3 and 2-4.

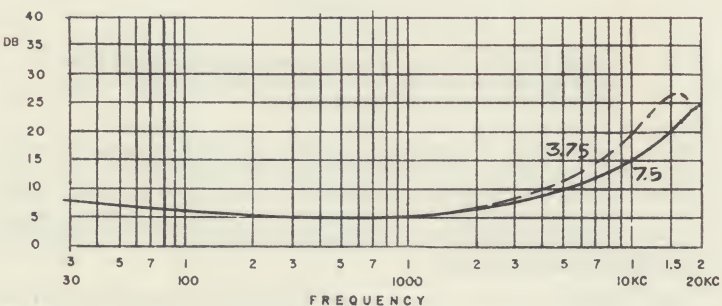


FIGURE 2-4 Record amplifier response for 7.5 and 3.75 inches per second tape speeds.

1.875 IPS OPERATION

The use of 1.875 ips should be approached from two directions. The first is when the designer wants to use the low speed as a "voice" mode or simply a third speed for tape economy with 3.75 and 7.5 ips being used for quality recording.

The second approach is when the designer is willing to utilize the latest tape technology, fine-gap heads, careful tape handling, and low-noise amplifier design. Under these circumstances it is possible to achieve true high-fidelity performance at 1.875 ips.

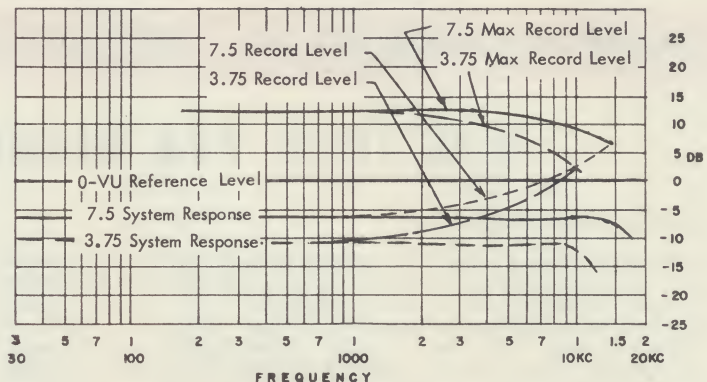


FIGURE 2-5 System response curves for fully equalized 7.5 and 3.75 ips operation. These response curves are shown at the maximum level that can be recorded to give 15 kc at 7.5 ips and 10 kc at 3.75 ips. The corresponding record amplifier curves are also shown as a matter of interest to indicate the maximum levels (at the intersections of the record current curves and the maximum record level curves at 15 kc for 7.5 ips and 10 kc for 3.75 ips).

It should be noted here that a compromise must be made in the playback head gap in order to handle a three octave speed range; a head suitable for best performance at 7.5 ips requires a gap of approximately 100 to 200 microinches. For 3.75 ips operation the playback gap should be between 80 and 160 microinches. At 1.875 the gap should be between 30 and 70 microinches for optimum performance with the latest tape for high-density recording.

The Nortronics F gap, which is 50 microinches, is ideally suited for the second approach at 1.875 ips. The gap loss on playback is small enough so that 15 kc. (125 microinch wavelength) can be effectively reproduced at this speed.

Special tape has now been developed which has an extremely smooth oxide surface. This very smooth surface results in intimate contact between the head gap and the tape. In addition the new tape has a very uniform thickness and a low friction surface characteristic to reduce flutter and noise.

The choice of bias in an optimum 1.875 ips system is even more critical than that described in the preceding paragraphs for 3.75 ips. The compromise bias chosen for response up to 15 kc. is an optimum or peak bias at about 5kc. Under these conditions the bias field does not take full advantage of the coating efficiently at low frequencies and correspondingly the high frequencies will be slightly attenuated due to overbias-demagnetization.

In a forthcoming Customer Engineering Bulletin operation at 1.875 ips for optimum fidelity will be covered in detail.

1.875 IPS VOICE OPERATION

As mentioned above this mode is generally a compromise to provide a third economy speed for voice recording. Assuming 7.5 ips and 3.75 ips are also used the designer should choose a bias of about 60 to 70% of the 7.5 ips peak bias. About 70 to 75% of the 7.5 ips reference level recording current should be used for 1.875 ips 0VU level. At 8 kc. the recording current should be boosted about 12 to 15 db. above the 1 kc. level; this will provide good system response to approximately 6 to 7 kc. with Nortronics 100 microinch gaps providing the user keeps the recording level at least 15 db. below reference level.

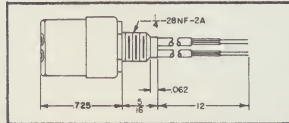
If any further information is desired on slow speed operation write to: THE NORTRONICS COMPANY, INC., CUSTOMER SERVICE DEPARTMENT, 8101 10th AVENUE NORTH, MINNEAPOLIS 27, MINNESOTA



Record/Play and Record Only Heads

4-Tr. Stereo	2-Tr. Stereo	2-Tr. Mono	2-Tr. Mono	2-Tr. Mono	Full Track	4-Channel	3-Channel
1000 THRU 1049 1200 THRU 1249	1800 THRU 1849 2000 THRU 2049	2600 THRU 2649	3000 THRU 3049 3200 THRU 3249	3100 THRU 3149	4100 THRU 4149	5600 THRU 5649	5700 THRU 5749

All heads shown above are No Mount styles. Rear Mount styles are also available. Simply add 50 to the number to denote Rear Mount style (ie: 1000 is No Mount—1050 is same head with Rear Mount). See illustration at right which shows details of the Rear Mount.



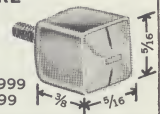
REAR MOUNT R/P

NEW HYPERBOLIC FACE

Available on most R/P heads. Gives improved tape to gap contact on recorders not requiring pressure pads, but can be used with pressure pads as well.

MINIATURE

AVAILABLE with Rear 1/4 x 2-56 Stud only R/P 4950 thru 4999 Er. 5350 thru 5399



Nortronics Model No.	No Mount	Rear Mount	Head Description	Head Function	Application (See Notes)	1 KC Inductance MHY	1 KC Impedance OHMS	DC Resistance OHMS	Net Each (No Mount)
1000	1050	1052	Standard 4-Track Stereo Hyperbolic Metal Face Laminated Cores	Record/Play	1	800	5000	700	\$21.00
1001	1051	1052		Record/Play	3	400	2500	390	21.00
1002	1052	1052		Record/Play	6	100	650	90	21.00
1200	1250	1252	Premium 4-Track Stereo Hyperbolic Metal Face Laminated Cores	Record/Play	1	800	5000	700	\$28.20
1201	1251	1252		Record/Play	3	400	2500	390	28.20
1202	1252	1252		Record/Play	6	100	650	90	28.20
1203	1253	1252		Record Only	8	50	400	90	28.20
1205	1255	1252		Record Only	4	200	1300	390	28.20
1207	1257	1252		Record/Play	5	200	1300	200	28.20
1800	1850	1852	Standard 2-Track Stereo Hyperbolic Metal Face Laminated Cores	Record/Play	1	800	5000	720	\$23.30
1801	1851	1852		Record/Play	3	400	2500	410	23.30
1802	1852	1852		Record/Play	6	100	650	130	23.30
2000	2050	2052	Premium 2-Track Stereo Hyperbolic Metal Face Laminated Cores	Record/Play	1	800	5000	720	\$30.30
2001	2051	2052		Record/Play	3	400	2500	410	30.30
2002	2052	2052		Record/Play	6	100	650	130	30.30
2003	2053	2052		Record Only	8	50	320	130	30.30
2007	2057	2052		Record/Play	5	200	1300	245	30.30
2600	—	—	Premium 2-Track Mono Hyperbolic Metal Face Laminated Cores	Record/Play	1	800	5000	400	\$15.90
2601	—	—		Record/Play	3	400	2500	165	15.90
2602	—	—		Record/Play	6	100	650	70	15.90
2603	—	—	Track .040 Off Center	Record Only	8	50	320	70	15.90
2630	—	—		Record Only	7	10	70	14	15.90
3000	3050	3052	Standard 2-Track Mono Hyperbolic Metal Face Laminated Cores	Record/Play	1	800	5000	400	\$ 8.40
3001	3051	3052		Record/Play	3	400	2500	165	8.40
3002	3052	3052		Record/Play	6	100	650	70	8.40
3100	—	—	2-Track Mono (Center Track) Cylindrical Metal Face Solid Cores	Record/Play	1	1000	6300	625	\$ 8.40
3101	3151	—		Record/Play	3	400	2500	350	8.40
3200	3250	3252	Premium 2-Track Mono Hyperbolic Metal Face Laminated Cores	Record/Play	1	800	5000	400	\$15.90
3201	3251	3252		Record/Play	3	400	2500	165	15.90
3202	3252	3252		Record/Play	6	100	650	70	15.90
3203	3253	3252		Record Only	8	50	320	70	15.90
3205	3255	3252		Play Only	4	200	1300	370	15.90
4100	4150	4152	Premium Full-Track Hyperbolic Metal Face Laminated Cores	Record/Play	3	250	1500	200	\$34.70
4101	4151	4152		Record Only	8	55	330	125	34.70
—	4950	—	Miniature	Record/Play	6	40	250	125	\$14.00*
5601	5651	5652	Premium 4-Channel Hyperbolic Metal Face Laminated Cores	Record Only	8	50	320	150	\$99.00
5602	5652	5652		Record/Play	6	90	600	100	99.00
5603	5653	5652		Record/Play	3	370	2200	690	99.00
5701	5751	5752	Premium 3-Channel Hyperbolic Metal Face Laminated Cores	Record/Play	3	340	2000	800	99.00
5702	5752	5752		Record/Play	6	100	650	260	99.00
5703	5753	5752		Record Only	8	50	400	260	99.00
5707	5757	5752		Record/Play	5	200	1300	450	99.00

Note: Add \$1.50 for Rear Mount except on 4950. Add \$6.00 for Rear Mount on 5650 and 5750 series. *(Rear Mount)

"Combo" Heads

4-Tr. Stereo	4-Tr. Mono	2-Tr. Stereo	2-Tr. Mono
6000 THRU 6024	6025 THRU 6049	6100 THRU 6124	6125 THRU 6149

Nortronics Model No.	No Mount	Rear Mount	Head Description	Head Function	Equivalent Head Specification Reference	Net Each
6000	—	—	4-Track Stereo "Combo" Metal Face	Erase, Record/Play	Record/Play 1201 Erase 1400	\$33.00
6001	—	—		Erase, Record/Play	Record Only 1203 Erase 1400	33.00
6002	—	—		Erase, Record/Play	Record/Play 1201 Erase 1401	33.00
6003	—	—		Erase, Record/Play	Record/Play 1009 Erase 1402	33.00
6009	—	—		Erase, Record/Play	Record/Play 1009 Erase 1401	33.00
6025	—	—	4-Track Mono "Combo" Metal Face, Center Track	Erase, Record/Play	Record/Play 1000 Erase 1402	\$18.00
6026	—	—		Erase, Record/Play	Record/Play 1001 Erase 1401	18.00
6100	—	—	2-Track Stereo "Combo" Metal Face	Erase, Record/Play	Record/Play 2001 Erase 2201	\$36.00
6125	—	—	2-Track Mono "Combo" Metal Face, Center Face	Erase, Record/Play	Record/Play 2601 Erase 3601	\$21.00

ERASE HEAD SPECIFICATIONS

Nortronics Standard Model No.	No Mount	Rear Mount	Head Description	Special Case Styles Available	Impedance Description	1 KC Inductance MHY	60 KC Impedance OHMS	Operating Erase Current MA	DC Resistance OHMS	60 KC Operating Voltage VOLTS	Net Each
1400	1450	1451	4-Track Stereo Erase Full Metal Face	B Case, L Case	Hi	80	30,000	3-5	270	90-150	\$12.00
1401	1451	1452		B Case, L Case	Med	10	2,800	10-15	40	28-42	12.00
1402	1452	1452		B Case, L Case	Lo	0.13	40	80-140	2	3-6	12.00
2200	2250	2251	2-Track Stereo Erase Full Metal Face	B Case, L Case	Hi	80	25,000	4.5-7.0	205	100-150	12.00
2201	2251	2251		B Case, L Case	Med	8	2,000	16-24	35	32-48	12.00
3600	3650	3651	2-Track Mono Erase Full Metal Face	B Case, L Case	Hi	80	25,000	4.5-7.0	205	100-150	\$ 8.00
3601	3651	3651		B Case, L Case	Med	8	2,000	16-24	35	32-48	8.00
4400	4450	4451	Full-Track Mono Erase Full Metal Face	B Case, L Case	Hi	40	12,000	10-15	88	25-35	\$14.00
4401	4451	4451		—	—	3.6	1,000	32-48	25	32-48	14.00
—	5350	—	Miniature	—	Med	5	1,200	28-42	38	32-48	\$12.00*

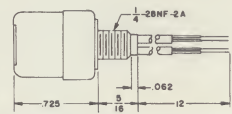
Note: L Case Heads—Same Prices as shown above. B Case Heads—Prices are double those shown above. †(Rear Mount) All specifications subject to change without notice. *For 60 db erasure of saturated tape. Voltages shown are RMS.

Note: Add \$1.50 for Rear Mount except 5350

Erase Heads

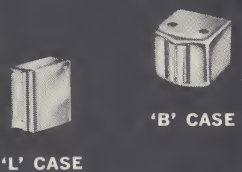
4-Tr. Stereo	2-Tr. Stereo	2-Tr. Mono	Full Track
1400 THRU 1449	2200 THRU 2249	3600 THRU 3649	4400 THRU 4449

All heads shown above are No Mount styles. Rear Mount styles are also available. Simply add 50 to number to denote Rear Mount style (ie: 1400 is No Mount—1450 is same head with Rear Mount). See illustration at right which shows details of the rear mount.



REAR MOUNT ERASE

SPECIAL ERASE CASE STYLES AVAILABLE

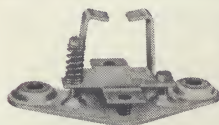


'B' CASE

'L' CASE



■ Tape Recording Accessories



UNIVERSAL MOUNTS

QUIK-KIT 74 Adjustable Head Mounting Assembly. Unique design permits alignment of head for height, tilt and azimuth. Two TG-7 Guide Posts can be added if desired; if space does not permit, tabs for guide posts can be snapped off. Base has hole for mounting on recorder. For all Nortronics no mount Record, Play or Record/Play heads except 3000 thru 3299 Series and miniature heads. Base Size (with tabs): 1 1/16" W, 1 27/32" L.

Without tabs: 1 1/16" W, 1 7/32" L.....Net Each **\$2.25**

QUIK-KIT 77 Adjustable Head Mounting Assembly. Identical to Quik-Kit 74 (including dimensions) but for no mount heads in 3000 thru 3299 Series.....Net Each **\$2.25**

QUIK-KIT 78 Adjustable Head Mounting Assembly. Identical to Quik-Kit 74 (including dimensions) but for no mount erase heads. Net Each **\$2.25**

L-5, L-Bracket for side-mount heads.....Net Each **\$.50**

L-6, As above but with narrow base.....Net Each **\$.70**

L-7, Identical to L-6 with reverse orientation to the bracket. Net Each **\$.70**

TAPE GUIDES

TG-7, Tape Guide Post. Vertically adjustable with tapped mounting hole in base. Chrome-Plated brass for long life.....Net Each **\$1.00**

TG-8, Tape Guide Plate. For Side-Mount heads and L-5, L-6 or L-7 bracket; gives additional guiding.....Net Each **\$.50**



ALIGNMENT TAPE

AT-100 Azimuth and Amplifier Alignment Tape. A 7.5 IPS full tack, direct oscillator master recording of frequencies from 40 to 10,000 cycles for checking azimuth and NAB equalization. 1000 cycle zero reference level tone included. Instructions are included. Net Each **\$4.95**

CONNECTOR ASSEMBLIES

CC-70—18" plug and shielded insulated cable assembly for Nortronics heads (Except Mono Combo).....Net Each **\$2.00**

CC-77—18" plug and shielded insulated cable assembly for Nortronics Mono Combo heads.....Net Each **\$2.00**

BIAS OSCILLATOR TRANSFORMERS

T60-T2—For transistor circuits. Features Ferroxcube E-cores for high Q, maximum efficiency and distortion-free waveform. Supplies 40-120 volts at 60-100 KC. With instructions.....Net Each **\$4.50**

T60E—For vacuum tube circuits, push-pull erase and bias power at operating frequencies from 40-70 KC; 120 volts rms to high impedance erase heads and 7 volts rms to low impedance erase heads. With instructions.....Net Each **\$4.50**

T60F—For vacuum tube circuits, push-pull erase and bias power at operating frequencies from 70-100 KC; output 150 volts rms tapped at 60 volts for high and medium impedance erase heads. With instructions.....Net Each **\$4.50**

■ Conversion Kits

For older Revere & Wollensak Models

WR-30—Converts all monophonic Wollensak and Revere tape recorders to full-track Record/Play. Fully assembled.....Net Each **\$57.00**

WR-35—Retains monophonic Record/Play capabilities—converts 2-track stereo to 4-track stereo Play. Fully assembled. Net Each **\$25.50**

WR-40—Converts monophonic machines to monophonic Record/4-track stereo Play. Fully assembled.....Net Each **\$32.50**

WR-60—Positive shifter provides four-channel monophonic Record/Play, 2 and 4-track stereo Erase/Record (requires additional second channel record pre-amp). Complete fully assembled. Net Each **\$49.50**

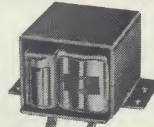
■ **Special Quik-Kits.** A Nortronics Quik-Kit is a package of hardware with complete instructions for making an installation of a Nortronics tape head on a recorder. Most Quik-Kits are universal in design to fit on most recorders. The Special Quik-Kits are designed to make installation on those recorders requiring a mount that is unique to that type of machine only.

QK	Make	Function	Model Nos.	Net Each
100	PENTRON	R/P	CT-1, HF-400, HT-225, MP-2, NL-1, NL-2, NL-3, PMC, PMD-1, PT-W3, PT-1, PT-72, PT-74, RWN, T-90, TM-1, TM-56, TR-4, TR-10, 9T3C, 9T3M, PB-A2, PB-1	\$ 2.00
300	PENTRON	Erase	CT-1, HF-400, HT-225, MP-2, NL-1, NL-2, NL-3, PMC, PMD-1, PT-W3, PT-1, PT-72, PT-74, RWN, T-90, TM-1, TM-56, TR-4, TR-10, 9T3C, 9T3M, NL-1S, NL-2S, NL-3S, PT-1S, PT-W3S, PT-72S, PT-74S, TM-4	\$ 2.25
101	BELL & HOWELL	R/P & Erase	600, 770, 775-G10 (Serial # ABOVE 2702)	\$ 4.25
102	SONY	R/P	101, 262-D, 262-SL machines and all Sony decks.	\$ 1.75
301	SONY	Erase	262-D machines and all Sony decks.	\$ 1.75
103	RCA & BELL SOUND	R/P	RCA 1YB11, 1YB26, 1YC11. Bell 601, 603	\$ 1.00
106	CONCERTONE	R/P	20/20, 30/30, 60 Series	\$12.00
304		Erase		\$12.00
82	TANDBERG	R/P	60, 64, 65, 74	\$ 2.00

■ **Special Head-Kits—**For some recorders the replacement heads and hardware are unique to those recorders alone. Nortronics, therefore, provides Special Head-Kits which contain all of the necessary heads, hardware and instructions to make a complete installation on these certain recorders.

HK	Make	Function	Model Nos.	Net Each
RP-1	RECORDIO	R/P	2A10 (late), 2A10B, 2A11, 2A11B	\$ 9.90
RP-2	REVERE & WOLLENSAK	R/P	Revere T-11-4, T-204-4, T-2200, TS-2205, TS-2225, Wollensak T-1515-4, T-1616-4, T-1818, T-1580	\$22.60
RP-4	WEBCOR	R/P	2202, 2202-1, 2205, 2205-1, 2300	\$12.00
RP-5	WEBCOR	R/P	2001, 2009, 2206-1, 2810, 2811, 2812, 2816, 2819, 2891, 2892, 2896, 2910, 2919, 2820, 2820-1C, 2821, 2822, 2827, 2897, 2923, 2950, 2955	\$12.50
RP-6	WEBCOR	R/P	For R/P Mono and Play Stereo—2820, 2820-1C, 2821, 2822, 2827, 2897, 2923, 2950, 2955	\$23.80
RP-8	SILVERTONE	R/P	7065, 7066, 7076, 7080, 7081, 9076	\$26.30
RP-9	SILVERTONE	R/P	6074, 7074, 8074	\$18.90
E-50	REVERE & WOLLENSAK	Erase	All 4-Track Mono	\$11.00
E-51	WEBCOR	Erase	All 4-Track Stereo	\$12.50
E-52	REVERE & WOLLENSAK	Erase	All 4-Track Stereo except Wollensak T-1580	\$16.25
E-53	SONY	Erase	262D, 262SL	\$15.25
E-54	SONY	Erase	101	\$11.25
E-57	LUXOR	Erase	NP-410A	\$15.25
E-58	WEBCOR	Erase	All old 2-Track Mono	\$ 8.00
E-59	WOLLENSAK	Erase	T-1580	\$17.75
RPE-20	REVERE & WOLLENSAK	R/P & Erase	Direct replacement for most older model monophonic machines having a Record/Play and Erase Assembly. Complete assembly mounted on special plate, wired and ready to install.	\$15.60

RPE-23 & RPE-24—These Nortronics Head-Kits are designed as premium quality replacements for several Shure "combination" heads originally developed in the early years of tape recording. They are called combination heads because the Erase and Record/Play functions (normally two separate heads) were contained in a single assembly and mounted as if they were one head. For specific replacements, see the table below. RPE-23 will fit the same models as the RPE-20 plus the very old model Revere & Wollensak monophonic machines.



RPE-23
RPE-24

■ Cross-Reference for Robins-Michigan/Magnetics and Shure Bros. Tape Heads

Nortronics Model No.	Quik-Kit No.	Description	Net Ea.* (Not including QK)
1851	—	ROBINS-M/M Type	
1801	66	3F20-101	\$24.80
3251	—	3F20-105	23.30
3001	20	3FM20-104, 3FM20-108	17.40
1800	38	3L20	8.40
1000	38	5B20LS, 7B17, 10B20LS	23.30
1000	103	5Q17, 5Q17-105	21.00
3000	20	5Q17, 5Q17-105	21.00
3601	18	7L17, 7L17-108, 10L17-104	8.40
2201	18	5S1, 5S1-103, 7EM12A	8.00
1401	18	5SS1	12.00
3600	18	9QE3	12.00
6002	38	40EM12	8.00
		5AV17	33.00
RPE-23	—	ROBINS-SHURE Type	\$15.60
		5TRB	
RPE-23	—	SHURE BROTHERS Type	\$15.60
		815, TR5B, TR5B-J, TR5D, TR5N, TR6H	
RPE-24	—	815H, TR5C, TR5K, TR5L, TR5Z-2, 816, TR5Z2-J	15.60
3101	20	817, TR16A, TR21C, TR21B, TR21A, TR16-J	8.40

*Quik-Kit numbers, when shown, indicate additional required mounting hardware. Order separately, using ADDITIONAL MOUNTING STYLES TABLE on opposite page.



FREE! TAPE HEAD REPLACEMENT GUIDE

By Nortronics. Specifies replacement for 440 Tape Recorders by Manufacturer and Model Number. See your local Nortronics Distributor or write to Nortronics. **FREE!**



Nortronics® Record, Playback, Record/Play, Erase & Combo Heads

THE NORTRONICS COMPANY, INC. 8101 TENTH AVENUE NORTH MINNEAPOLIS, MINNESOTA 55427

DESCRIPTION.

NORTRONICS magnetic tape heads are designed to offer highest quality performance and long dependable service. As the chief exponent and largest manufacturer of laminated core heads, NORTRONICS now offers a completely new line, with heads available in either PREMIUM or STANDARD laminated versions. NORTRONICS is also including the new "COMBO" heads which combine Record/Play/Erase into one head.

The STANDARD versions offer improved high frequency performance over that of the conventional solid-core heads, plus the added features of hyperbolic all-metal face and precision deposited quartz gaps.

The PREMIUM series is a fully professional line of tape heads giving unsurpassed performance for broadcast, studio and exacting semi-professional applications. Long life and extended high frequency response at slower tape speeds are among the benefits of the features listed below:

- Fine laminated, precision-lapped, low loss core structures.
- Deposited quartz gaps, resulting in exceptionally clean sharp gap edges.
- Hyperbolic face contour gives intimate tape-to-gap contact without need for pressure pads, but is designed to allow use with pressure pads as well.
- Highly polished all-metal faces, greatly reduce oxide build-up and the need for frequent head cleaning.
- Compatible mechanically and electrically with older model NORTRONICS heads.
- Superbly shielded against external magnetic fields.

The "Combo" series heads combine all of the features of the Premium series above, except the hyperbolic face contour. This series has a Record/Play Head and an Erase Head in one case.

MOUNTING STYLES.

The wide variety of available mounting styles, track types and impedances make it possible to find a NORTRONICS head to suit almost any audio application. Your new NORTRONICS head is supplied in two basic mounting styles, NO MOUNT and REAR MOUNT. REAR MOUNT heads have a rear mounting stud with 12-inch shielded wires. NO MOUNT heads have no brackets, screws or wires attached to them and are used directly in several popular brands of tape recorders. When required, NO MOUNT heads may be quickly adapted to SIDE MOUNT and BASE MOUNT styles by using the proper NORTRONICS Quik-Kit which is available where you purchased your NORTRONICS tape head. Complete, detailed instructions are included with each Quik-Kit. The six basic Quik-Kits used for adapting NO MOUNT heads are:

- | | |
|-------|---|
| QK-18 | Adapts all standard No Mount Erase Heads to Side Mount. |
| QK-19 | Adapts all standard No Mount Erase Heads to Base Mount. |
| QK-20 | Adapts 3000 thru 3049, 3100 thru 3149, and 3200 thru 3249 No Mount R/P Heads and Record Only Heads to Side Mount. |
| QK-21 | Adapts 3000 thru 3049, 3100 thru 3149, and 3200 thru 3249 No Mount R/P Heads and Record Only Heads to Base Mount. |
| QK-38 | Adapts all other No Mount R/P Heads, Record Only Heads, and Combo Heads to Side Mount. |
| QK-66 | Adapts all other No Mount R/P Heads, Record Only Heads, and Combo Heads to Base Mount. |

REPLACEMENT OR CONVERSION.

NORTRONICS heads are the ideal selection for replacement of existing heads, converting to 2 or 4-track stereophonic sound and for installation on new tape equipment. In the majority of cases, replacements will be made on a direct basis. For exam-

ple, a 2-track stereo head will be used to replace a worn 2-track stereo head. It is often possible to interchange head types to modernize equipment or for special applications. An example of this would be substituting a 4-track stereo head for a 2-track stereo head to bring the recorder up to date, or substituting a Full track monophonic head for a 2-track monophonic head to make a recorder suitable for broadcast purposes. In such interchanges, it is important to bear in mind that mechanical and electrical compatibility is required between head types to avoid operating difficulties.

LAMINATED vs. SOLID CORE HEADS.

Heads for magnetic tape recorders are generally manufactured with either laminated or solid metal cores. Excellent heads can be made in either type and NORTRONICS produces both but specializes in laminated heads because the unexcelled quality and superior performance of this type head is demanded in ever increasing numbers by knowledgeable audiophiles, serious tape enthusiasts, and original equipment manufacturers for use in their best recorders. The NORTRONICS heads featuring professional type laminated core structures with ultra-fine gaps result in magnificent playback frequency response. At a tape speed of 7.5 ips, a flat response from 50 to 15,000 cps is readily attainable, with useful output down to 30 cps and up to 20,000 cps. At a speed of 3.75 ips, the response is flat from 50 to 10,000 cps with useful output down to 30 cps and up to 15,000 cps.

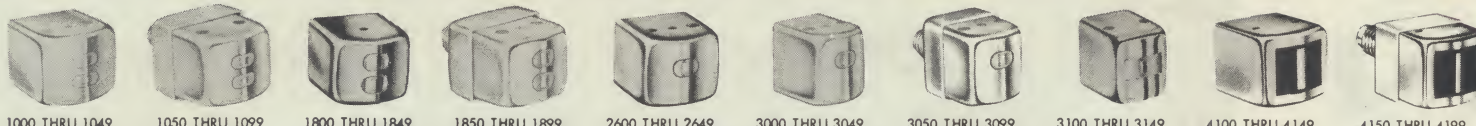
Laminated heads are more expensive to construct because permissible tolerances are considerably tighter, materials used are costlier and rigid tests must be made at each production level. The grinding, lapping and polishing operations require a high degree of skill and equipment of specialized design. After the head is completely finished, it must go through a further series of final checks and tests before it is approved for release. Any head which fails to pass through the stringent checks of Final Testing is automatically rejected. The end result is a laminated head of superior design . . . a superlative product of such exacting quality, it is literally capable of bringing out the best possible performance of any tape recorder with which it is used.

Laminated heads have clearly demonstrable advantages over solid core types which more than justify the extra care and expense required to manufacture them. As stated before, excellent heads can be made in either type and NORTRONICS produces BOTH. The major advantages of laminated design are lower eddy current and hysteresis losses in the core at high audio frequencies during playback. Drop-off in high frequencies is actually due to both the gap effect and core losses. As a result of the reduced core losses in laminated heads, the output at high frequencies is correspondingly greater than that obtained from an equivalent solid core head with the same size gap. Consequently, with the tape speeds in current popular use (7.5 and 3.75 ips), laminated heads can use a wider gap for improved recording characteristics while attaining essentially the same playback frequency response as solid core heads. In addition, because of the improved efficiency and sensitivity of laminated heads, a greater depth of metal can be left on the pole faces of the head. This insures longer operating life before wear makes replacement necessary. Despite anything you might have heard to the contrary, TAPE HEADS DO WEAR OUT!

At the present stage of the tape recording art, the finest heads available are of laminated design. NORTRONICS is continuously engaged in an extensive research program covering a wide area of interest to constantly improve the performance and quality of its products while still maintaining a sensible price structure. Several design concepts utilizing a new approach to materials not presently being used in the production of magnetic tape heads are currently undergoing evaluation. These materials require novel processing techniques and some of them hold great promise for the future. You may be sure that when any improvements either in head design or the materials used in those designs are ready to be moved from Research to Production, NORTRONICS will produce them.

TAPE HEAD SPECIFICATIONS

■ Record/Play and Record Only Heads See next page for dimensions.



1000 THRU 1049 1050 THRU 1099 1800 THRU 1849 1850 THRU 1899 2600 THRU 2649 3000 THRU 3049 3050 THRU 3099 3100 THRU 3149 4100 THRU 4149 4150 THRU 4199



4950 THRU 4999 5600 THRU 5649 5650 THRU 5699 5700 THRU 5749 5750 THRU 5799

NEW
HYPERBOLIC
FACE



AVAILABLE ON ALL R/P
HEADS. GIVES IMPROVED
TAPE TO GAP CONTACT
ON RECORDERS NOT RE-
QUIRING PRESSURE PADS.

NORTRONICS MODEL NO.		HEAD DESCRIPTION	HEAD FUNCTION	APPLICATION (See Notes)	1 KC INDUCTANCE		1 KC IMPEDANCE		MAXIMUM BIAS FREQUENCY		DC RESISTANCE		GAP SPACER		TRACK WIDTH		TRACK SPACING Center-to-Center		1 KC CROSSTALK REJECTION		Average 7.5 IPS constant-current R/P characteristics, using 3M190 Tape, peak biased at 1kc and recorded 12 db below tape saturation.					
NO MOUNT	REAR MOUNT				60 KC PEAK BIAS	BIAS VOLTAGE RMS 60KC	RECORD CURRENT	1 KC OUTPUT	10 KC/1 KC RATIO																	
										MHY	OHMS	KC	OHMS	MILS	INCH	INCH	DB	MA	VOLT	UA	M A	DB				
1000	1050	STANDARD 4-TRACK STEREO Hyperbolic Metal Face Laminated Cores	Record/Play	1	800	5000	80	700	0.1	.043	.136	55	0.30	45	25	2.4	-3									
1001	1051		Record/Play	3	400	2500	100	390	0.1	.043	.136	55	0.42	35	35	1.6	-3									
1002	1052		Record/Play	6	100	650	140	90	0.1	.043	.136	55	1.1	20	70	0.8	-4									
1008	-		Record/Play	6	110	700	100	210	0.2	.043	.136	55	0.5	12	50	1.2	-3									
1009	-		Record/Play	3	500	3300	100	700	0.2	.043	.136	55	0.15	25	23	3.0	-3									
1200	1250	PREMIUM 4-TRACK STEREO Hyperbolic Metal Face Laminated Cores	Record/Play	1	800	5000	80	700	0.1	.043	.136	55	0.16	45	25	2.6	+1									
1201	1251		Record/Play	3	400	2500	100	390	0.1	.043	.136	55	0.25	35	35	1.8	+1									
1202	1252		Record/Play	6	100	650	140	90	0.1	.043	.136	55	0.70	18	70	0.9	0									
1203	1253		Record Only	8	50	400	250	90	0.5	.043	.136	55	0.65	7.5	60	-	-									
1205	1255		Record Only	4	200	1300	120	390	0.5	.043	.136	55	0.26	20	38	-	-									
1207	1257		Record/Play	5	200	1300	120	200	0.1	.043	.136	55	0.40	25	50	1.3	+1									
1210	-		Record Only	7	10	70	500	32	0.5	.043	.136	55	1.3	3.0	140	-	-									
1221	-		Play Only	3	500	3300	100	390	0.05	.043	.136	55	0.25	50	-	1.8	2									
1800	1850		STANDARD 2-TRACK STEREO Hyperbolic Metal Face Laminated Cores	Record/Play	1	800	5000	60	720	0.1	.080	.160	55	0.4	65	30	3.4	-3								
1801	1851	Record/Play		3	400	2500	100	410	0.1	.080	.160	55	0.6	45	40	2.2	-3									
1802	1852	Record/Play		6	100	650	150	130	0.1	.080	.160	55	1.1	20	80	1.1	-4									
2000	2050	PREMIUM 2-TRACK STEREO Hyperbolic Metal Face Laminated Cores	Record/Play	1	800	5000	60	720	0.1	.080	.160	55	0.25	55	30	3.6	-1									
2001	2051		Record/Play	3	400	2500	100	410	0.1	.080	.160	55	0.33	40	40	2.4	+1									
2002	2052		Record/Play	6	100	650	150	130	0.1	.080	.160	55	0.80	20	80	1.2	0									
2003	2053		Record Only	8	50	320	200	130	0.5	.080	.160	55	0.70	9	75	-	-									
2007	2057		Record/Play	5	200	1300	100	245	0.1	.080	.160	55	0.40	30	60	1.8	+1									
2010	-		Record Only	7	10	72	500	27	0.5	.080	.160	55	1.7	3.3	200	-	-									
2021	-		Play Only	2	450	3300	80	410	0.05	.080	.160	55	0.46	55	-	2.2	+2									
2047	-		R/P Dual Impedance	6	100	650	150	130	0.1	.080	.160	55	0.80	20	80	1.2	0									
2600	-	PREMIUM 2-TRACK MONO Hyperbolic Metal Face Laminated Cores Track .040 Off Center	Impedance	3	400	2500	100	410	0.1	.080	.160	55	0.33	40	40	2.4	+1									
2601	-		Record/Play	1	800	5000	60	400	0.1	.080	-	-	0.25	55	30	3.6	+1									
2601	-		Record/Play	3	400	2500	100	165	0.1	.080	-	-	0.33	40	40	2.4	+1									
2602	-		Record/Play	6	100	650	150	70	0.1	.080	-	-	0.80	20	80	1.2	0									
2603	-		Record Only	8	50	320	200	70	0.5	.080	-	-	0.70	9	75	-	-									
2630	-	Record Only	7	10	70	500	14	0.5	.080	-	-	1.7	3.3	200	-	-										
3000	3050	STANDARD 2-TRACK MONO Hyperbolic Metal Face Laminated Cores	Record/Play	1	800	5000	60	400	0.1	.080	-	-	0.4	65	30	3.4	-3									
3001	3051		Record/Play	3	400	2500	100	165	0.1	.080	-	-	0.6	45	40	2.2	-3									
3002	3052		Record/Play	6	100	650	150	70	0.1	.080	-	-	1.1	20	80	1.1	-4									
3100	-	2-TRACK MONO (Center Track) Cylindrical Metal Face Solid Cores	Record/Play	1	1000	6300	60	625	0.16	.090	-	-	0.65	60	22	5.0	-9									
3101	3151		Record/Play	3	400	2500	80	350	0.16	.090	-	-	0.8	25	30	3.0	-9									
3200	3250	PREMIUM 2-TRACK MONO Hyperbolic Metal Face Laminated Cores	Record/Play	1	800	5000	60	400	0.1	.080	-	-	0.25	55	30	3.6	+1									
3201	3251		Record/Play	3	400	2500	100	165	0.1	.080	-	-	0.33	40	40	2.4	+1									
3202	3252		Record/Play	6	100	650	150	70	0.1	.080	-	-	0.80	20	80	1.2	0									
3203	3253		Record Only	8	50	320	200	70	0.5	.080	-	-	0.70	9	75	-	-									
3205	3255		Record Only	4	200	1300	150	370	0.5	.080	-	-	0.30	22	40	-	-									
4100	4150	PREMIUM FULL-TRACK Hyperbolic Face Laminated Cores	Record/Play	3	250	1500	80	200	0.16	.260	-	-	1.2	40	90	4.0	0									
4101	4151		Record Only	8	55	330	250	125	0.5	.260	-	-	0.8	24	100	-	-									
4102	-		Record/Play	6	100	600	100	125	0.16	.260	-	-	1.5	30	120	2.5	0									
4103	-		Record Only	7	10	60	500	6	0.5	.260	-	-	4.0	9	320	-	-									
4104	-		Record Only	8	30	190	200	22	0.5	.260	-	-	1.8	20	180	-	-									
-	4950	MINIATURE		Record/Play	6	40	250	150	125	0.16	.024	-	-	0.65	8	50	0.45	0								
5601	5651	PREMIUM 4-CHANNEL Hyperbolic Metal Face Laminated Cores	Record Only	8	50	320	220	150	0.5	.037	.071	50	0.6	7	60	-	-									
5602	5652		Record/Play	6	90	600	220	100	0.1	.037	.071	50	0.7	15	60	0.7	0									
5603	5653		Record/Play	3	370	2200	80	690	0.1	.037	.071	50	0.3	30	34	1.4	0									
5604	-		Record Only	7	12	75	500	55	0.5	.037	.071	50	2.0	4	110	-	-									
5701	5751	PREMIUM 3-CHANNEL Hyperbolic Metal Face Laminated Cores	Record/Play	3	340	2000	100	800	0.1	.043	.100	55	0.25	35	35	1.8	+1									
5702	5752		Record/Play	6	100	650	140	260	0.1	.043	.100	55	0.70	18	60	0.9	0									
5703	5753		Record Only	8	50	400	250	260	0.5	.043	.100	55	0.65	7.5	60	-	-									
5707	5757		Record/Play	5	200	1300	120	450	0.1	.043	.100	55	0.40	20	50	1.3	+1									
5710	-		Record Only	7	10	70	500	100	0.5	.043	.100	55	1.7	3.3	200	-	-									

APPLICATION NOTES:

1. High-impedance general-purpose record/play or playback-only head for vacuum-tube circuits.
2. High-impedance playback-only head for vacuum-tube circuits.
3. Medium-impedance record/play head for vacuum-tube or transistor circuits.
4. Medium-impedance record-only head for vacuum-tube circuits.
5. Medium-low-impedance record/play for transistor circuits.
6. Low-impedance record/play for transistor circuits.
7. Special low-impedance record-only for vacuum-tube or transistor circuits in duplicators and professional recorders.
8. Low-impedance record-only for vacuum-tube or transistor circuits.

THIS FORM SUPERSEDES ALL PREVIOUSLY PRINTED 7079 SERIES FORMS-PRINTED IN USA-SEPTEMBER, 1965-PAGE 2 OF 4-FORM NO. 7079G



Nortronics® Record, Playback, Record/Playback and Erase Heads

THE NORTRONICS COMPANY, INC. 8101 TENTH AVENUE NORTH MINNEAPOLIS, MINNESOTA 55427

The NORTRONICS professional 8000 series of magnetic tape heads are designed to offer highest quality performance and long dependable service. To find the proper Nortronics replacement head for your Ampex, Crown, Magnecord, Tape-A-Thon or R.C.A. professional recorder, see Form No. 7226, "Replacement Heads for Professional Recorders."

These heads have special characteristics and are not to be confused with the Nortronics standard or premium series of heads. See Form No. 7227 for professional series head prices.

Record Only, Play Only and Record/Play Heads (See the reverse side of this sheet for Erase Head Data)



8000 Series
Full Track



8200 Series
2-Track Stereo

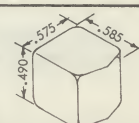


8400 Series
2-Track Mono



8600 Series
4-Track Stereo

All Nortronics professional series record, playback and record/playback heads have the same case dimensions (see figure at right). This allows easy conversion from one track system to another.



SEE THE REVERSE SIDE OF THIS SHEET FOR HEAD MOUNTING INFORMATION

HEAD DESCRIPTION	NORTRONICS MODEL NUMBER (No Mount)	HEAD FUNCTION	INDUCTANCE, 1 KC		IMPEDANCE, 1 KC		RESISTANCE, D.C.		GAP SPACER	TRACK WIDTH	TRACK SPACING Center-to-Center INCH	1 KC CROSS TALK REJECTION DB.	AVERAGE 7.5IPS constant-current R/P characteristics, using 3M190 Tape, peak biased at 1 kc and recorded 12 db below tape saturation.		RECORD CURRENT U.A.	1 KC OUTPUT M.V.	10 KC/1 KC RATIO DB.
			MHY.	OHMS.	OHMS.	OHMS.	OHMS.	MILS.					PEAK BIAS CURRENT MA.	BIAS VOLTAGE VOLTS			
FULL TRACK Hyperbolic Face Laminated Cores	8000	Play	1000	6000	400	0.16	.260									7	-
	8001	Record	10	60	6	0.5	.260						4.0	15	320		-
	8002	Record	37	230	60	0.16	.260						1.0	30	100		-
	8003	Play	400	2500	285	0.16	.260									6	0
	8004	Record	3.6	24	3	0.5	.260						1.6	8*	1400		-
	8005	Record	30	190	22	0.5	.260						1.8	30	180		-
	8006	Record/Play	250	1500	200	0.16	.260						1.2	40	90	4.0	0
2-TRACK STEREO Hyperbolic Metal Face Laminated Cores	8007	Record/Play	1.2	8	3.2	0.16	.260						12.0	5*	800	0.25	0
	8200	Play	800	5000	380	0.16	.080	.160	55							3.5	0
	8201	Record	10	72	27	0.5	.080	.160	55	1.7	6	200					-
	8202	Play	200	1300	190	0.16	.080	.160	55								-
	8203	Record	30	200	72	0.5	.080	.160	55	0.9	15	100					-
	8204	Record	50	320	130	0.5	.080	.160	55	0.7	18	75					-
	8205	Play	400	2500	250	0.1	.080	.160	55							2.1	0
	8206	Record	3.7	25	16	0.5	.080	.160	55	4.3	5.5*	250					-
	8207	Record/Play	1.2	7.5	1.5	0.1	.080	.160	55	7	2.0*	800	0.4				-
	8208	Play	450	3300	410	0.05	.080	.160	55							2.2	+2
	8209	Record/Play	400	2500	410	0.1	.080	.160	55	0.33	60	40	2.4			+2	
	8214	Record	2.0	15	5.5	0.5	.080	.160	55	5.0	3.5	250					-
2-TRACK MONO Hyperbolic Metal Face Laminated Cores	8400	Play	800	5000	380	0.16	.080									3.5	-
	8401	Record	10	75	14	0.5	.080						1.7	6	200		-
	8402	Play	20	150		0.1	.080									0.5	0
	8403	Record/Play	400	2500	165	0.1	.080						0.33	60	40	2.4	+1
	8404	Record	50	320	70	0.5	.080						0.7	18	75		-
	8405	Play	400	2500	165	0.1	.080									2.2	-1
	8406	Play	500	3300	165	0.05	.080									2.2	+3
	8407	Play	1.2	7.5		0.1	.080						7	2.0*	800	0.1	-
4-TRACK STEREO Hyperbolic Metal Face Laminated Cores	8408	Record/Play	200	1300	110	0.1	.080						0.4	30	60	1.8	+1
	8414	Record	2.0	15	5.5	0.5	.080						5.0	3.5	250		-
	8600	Play	800	5000	700	0.1	.043	.136	55							2.6	+1
	8601	Play	500	3300	390	0.05	.043	.136	55							1.8	+2
	8602	Record	30	200	60	0.5	.043	.136	55	0.80	12	78					-
	8603	Record	50	400	260	0.5	.043	.136	55	0.65	15	60					-
	8604	Record	10	70	32	0.5	.043	.136	55	1.3	60	140					-
	8607	Record/Play	200	1300	200	0.1	.043	.136	55	0.4	40	50	1.3			+1	
	8608	Record/Play	400	2500	390	0.1	.043	.136	55	0.25	60	35	1.8			+1	
	8614	Record	2.0	15	6.0	0.5	.043	.136	55	3.8	2.5	250					-

*80 KC

Specifications subject to change without notice.

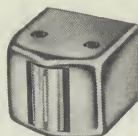
YOUR LOCAL DEALER

HYPERBOLIC FACE



Incorporated on all professional series heads. Gives intimate tape-to-gap contact without need for pressure pads, but is designed to allow use with pressure pads as well.

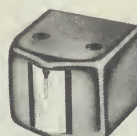
■ **Erase Heads** (SEE THE REVERSE SIDE OF THIS SHEET FOR RECORD, PLAYBACK, AND RECORD/PLAYBACK HEAD DATA)



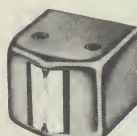
8100 SERIES
Full Track



8300 SERIES
2-Track Stereo



8500 SERIES
2-Track Mono



8700 SERIES
4-Track Stereo

All Nortronics professional series erase heads have the same case dimensions (see figure at right). This allows easy conversion from one track system to another.



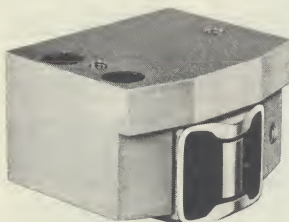
HEAD DESCRIPTION	NORTRONICS MODEL NUMBER NO MOUNT	INDUCTANCE, 1 KC MHY	IMPEDANCE, 60 KC OHMS	RESISTANCE, D.C. OHMS	OPERATING VOLTAGE 60 KC, RMS VOLT	OPERATING VOLTAGE 100 KC, RMS VOLT	ERASE # CURRENT OPERATING MA
FULL TRACK Full Metal Face	8101	40	12,000	88	100-150	160-200	10-15
	8102	0.085	24	1.3	6-9	10-14	250-350
	8104	3.6	1,000	25	32-48	50-70	32-48
	8105	0.6	250*	4	15-22*	20-30	80-100
	8106	6	1,800	30	—	75-95	30-40
	8109	2.6	600*	20	25-35	43-57	42-57
	8110	2.6	600*	20	35-46*	—	42-52
2-TRACK STEREO Full Metal Face	8301	50	20,000	205	100-150	160-200	4.5-7.0
	8302	0.2	50	2	5-8	8-15	100-150
	8304	8	2,000	35	32-48	50-70	16-24
	8306	0.7	250*	3.6	15-22*	20-30	40-70
	8307	8	2,000	35	40-55*	—	16-24
2-TRACK MONO Full Metal Face	8501	50	20,000	205	100-150	160-200	4.5-7.0
	8502	0.2	50	2	5-8	8-15	100-150
	8504	8	2,000	35	32-48	50-70	16-24
	8506	0.7	250*	3.6	15-22*	20-30	40-70
4-TRACK STEREO Full Metal Face	8701	10	2,800	40	28-42	45-60	10-15
	8702	0.13	40	2	3-6	5-12	80-140
	8704	80	30,000	270	90-150	150-200	3-5
	8708	2.0	500*	6	15-25*	20-30	30-50

† For 56 DB erasure of saturated tape.

*80 KC.

Specifications subject to change without notice.

■ **Head Mounting Brackets for Professional Machines**



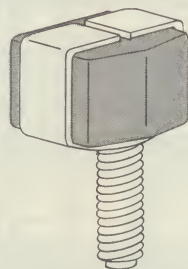
QK-76 WITH NORTRONICS HEAD MOUNTED IN PLACE

QK-76 is a neatly packaged kit containing all of the hardware and detailed illustrated instructions necessary to adapt a Nortronics head to the shield cup of an Ampex head nest. It consists of a precision cast aluminum block; spacers; screws; connector plug; and complete instructions. All other parts necessary are utilized from the original Ampex equipment. Write for Form No. 7201/7202 for description and listing of recommended heads.



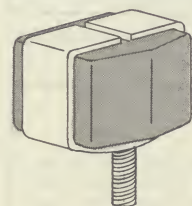
QK-81 WITH 3 NORTRONICS HEADS MOUNTED IN PLACE ON MAGNECORD PT6 MACHINE

QK-81 is a completely assembled kit which allows conversion of the Magnecord PT6 and PT63 type machines to modern heads. The third head position can be used for monitor or stereo playback. Instructions are included to adapt the original Magnecord electronics to accept the new Nortronics heads and meet NAB standards on equalization. Response to 15 KC at 7.5 IPS and 10 KC at 3.75 IPS. Write for Form No. 7242 for description of the QK-81 and recommended heads.



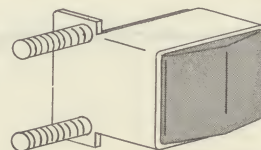
QK-35 MOUNTED ON NORTRONICS HEAD

QK-35 is a special base-mount bracket kit for adapting Nortronics no-mount heads for replacement of Brush Heads or in any application requiring a large base mounting stud. (Stud—1/4-28 X 5/8).



QK-66 MOUNTED ON NORTRONICS HEAD

QK-66 is a standard base-mount bracket kit for adapting Nortronics no-mount heads for most base-mount applications. (Stud—6-32 X 5/16).



QK-38 MOUNTED ON NORTRONICS HEAD

QK-38 is a standard side-mount bracket kit for adapting Nortronics no-mount heads for most side-mount applications.

TAPE HEAD SPECIFICATIONS

■ Erase Heads

See below for dimensions.



OPTIONAL LARGE CASE ("L" CASE) ERASE HEAD
Add "L" to standard No Mount model number as indicated in 'Optional Large Case' column.

NORTRONICS STANDARD MODEL NO.		OPTIONAL LARGE CASE	HEAD DESCRIPTION	IMPEDANCE DESCRIPTION	1 KC INDUCTANCE		OPERATING ERASE CURRENT*	DC RESISTANCE	60 KC OPERATING VOLTAGE
NO MOUNT	REAR MOUNT				MHY	OHMS	MA	OHMS	VOLT
1400	1450	1400L	4-TRACK STEREO ERASE Full Metal Face	Hi	80	30,000	3-5	270	90-150
1401	1451	1401L		Med.	10	2,800	10-15	40	28-42
1402	1452	1402L		Lo	0.13	40	80-140	2	3-6
2200	2250	2200L	2-TRACK STEREO ERASE Full Metal Face	Hi	80	25,000	4.5-7.0	205	100-150
2201	2251	2201L		Med.	8	2,000	16-24	35	32-48
2202	-	-		Lo	0.20	50	100-150	2	5-8
2203	-	-	2-TRACK MONO ERASE Full Metal Face	Med.	4	800	20-25	17	20-30
3600	3650	3600L		Hi	80	25,000	4.5-7.0	205	100-150
3601	3651	3601L		Med.	8	2,000	16-24	35	32-48
3602	-	-	FULL-TRACK MONO ERASE Full Metal Face	Lo	0.20	50	100-150	2	5-8
3604	-	-		Med.	4	800	20-25	17	20-30
4400	4450	4400L		Hi	40	12,000	10-15	88	100-150
4401	4451	-	MINIATURE	Med.	3.6	1,000	32-48	25	32-48
-	5350	-		Med.	5	1,200	28-42	38	32-48

*For 60 db erasure of saturated tape.

■ "Combo" Heads

See below for dimensions.



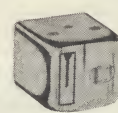
6000 THRU 6024



6025 THRU 6049



6100 THRU 6124



6125 THRU 6149

NORTRONICS MODEL NO.		HEAD DESCRIPTION	HEAD FUNCTION	EQUIVALENT HEAD SPECIFICATION REFERENCE	
NO MOUNT	REAR MOUNT				
6000	-	4-TRACK STEREO "COMBO" Metal Face	Erase, Record/Play	Record/Play 1201	Erase 1400
6001	-		Erase, Record Only	Record Only 1203	Erase 1400
6002	-		Erase, Record/Play	Record/Play 1201	Erase 1401
6003	-		Erase, Record/Play	Record/Play 1000	Erase 1402
6009	-	4-TRACK MONO "COMBO" Metal Face Center Track	Erase, Record/Play	Record/Play 1009	Erase 1401
6025	-		Erase, Record/Play	Record/Play 1000	Erase 1402
6026	-		Erase, Record/Play	Record/Play 1001	Erase 1401
6100	-	2-TRACK STEREO "COMBO" Metal Face	Erase, Record/Play	Record/Play 2001	Erase 2201
6127	-	2-TRACK MONO "COMBO" Metal Face Center Track	Erase, Record/Play	Record/Play 2601	Erase 3601

QK-18 adapts all standard No Mount Erase Heads to Side Mount.

QK-19 adapts all standard No Mount Erase Heads to Base Mount.

QK-20 adapts 3000 thru 3049, 3100 thru 3149, and 3200 thru 3249 No Mount R/P Heads and Record Only Heads to Side Mount.

QK-21 adapts 3000 thru 3049, 3100 thru 3149, and 3200 thru 3249 No Mount R/P Heads and Record Only Heads to Base Mount.

QK-38 adapts all other No Mount R/P Heads, Record Only Heads, and Combo Heads to Side Mount.

QK-66 adapts all other No Mount R/P Heads, Record Only Heads, and Combo Heads to Base Mount.

All specifications subject to change without notice.

TYPICAL DIMENSIONS

1000 THRU 1049 1200 THRU 1249 1800 THRU 1849 2000 THRU 2049 2600 THRU 2649 4100 THRU 4149 5600 THRU 5649 5700 THRU 5749 6000 THRU 6049 6100 THRU 6149	1050 THRU 1099 1250 THRU 1299 1850 THRU 1899 2050 THRU 2099 4150 THRU 4199 5650 THRU 5699 5750 THRU 5799	3000 THRU 3049 3100 THRU 3149 3200 THRU 3249	1400 THRU 1449 2200 THRU 2249 3600 THRU 3649 4400 THRU 4449	1450 THRU 1499 2250 THRU 2299 3650 THRU 3699 4450 THRU 4499
		3050 THRU 3099 3250 THRU 3299	"L" CASE ERASE	4950 THRU 4999 5350 THRU 5399

AT - 100 AZIMUTH AND AMPLIFIER ALIGNMENT TAPE



A 7.5 IPS Full Track master professional tape. It contains frequencies from 40 to 10,000 cycles for checking azimuth and equalization Full instructions recorded on tape.

Specifications for the Nortronics 8000 series (Professional Series) of magnetic tape heads are listed in form No. 7222.

CROSS REFERENCE TABLE FOR NORTRONICS HEADS

ORIGINAL DISTRIBUTOR HEAD NUMBER	CURRENT DISTRIBUTOR HEAD NUMBER	OPTIONAL AND INTERCHANGEABLE DISTRIBUTOR NO.	INDUCTANCE WHY "R" HAS RECORD GAP "F" HAS 50 U-IN. GAP	CURRENT O.E.M. EQUIVALENT MODEL NUMBER	ORIGINAL O.E.M. MODEL NUMBER	ALTERNATE AND CURRENT O.E.M. MODEL NUMBER	OBSOLETE AND DISCONTINUED MODEL NUMBERS
4-TRACK STEREO RECORD/PLAY AND RECORD ONLY							
1000	1000	1200	800	B2Q2K	CSQ2K	PB2Q2K	TLB2, TLD-L1
1001	1001	1201	400	B2Q7K	CSQ7K	PB2Q7K	TLB7, TLB-7K
1002	1002	1202	100	B2Q4K	CSQ4K	PB2Q4K	TLB4, TLB4K
1003		1203	50R		CSQ4R	PB2Q4R	TLB4R
1004	1000	1200	800	B2Q2K	CSQ1K	PB2Q2K	TLB1K, TLB1
1005		1205	200R		CSQ7R	PB2Q7R	TLB7R
1008			120	B2Q6N2			
1009	1009		500	B2Q2N2			
1100	1200	1000	800	PB2Q2K	ASQ2K	B2Q2K	
1101	1201	1001	400	PB2Q7K	ASQ7K	B2Q7K	
1102	1202	1002	100	PB2Q4K	ASQ4K	B2Q4K	
1103	1203		50R	PB2Q4R	ASQ4R		
1104	1200	1000	800	PB2Q2K	ASQ1K	B2Q2K	
1105	1205		200R	PB2Q7R	ASQ7R		
1106	1210		10R	PB2Q8R	ASQ23R		
1107	1207		200	PB2Q6K	ASQ6K		
1200	1200	1000	800	PB2Q2K	ASQ2K	B2Q2K	TLB2, CSQ2K
1201	1201	1001	400	PB2Q7K	ASQ7K	B2Q7K	TLB7, CSQ7K
1202	1202	1002	100	PB2Q4K	ASQ4K	B2Q4K	TLB4, CSQ4K
1203	1203		50R	PB2Q4R	ASQ4R		TLB4R, CSQ4R
1205	1205		200R	PB2Q7R	ASQ7K		TLB7R, CSQ7R
1207	1207		200	PB2Q6K	ASQ6K	B2Q6K	CSQ6K
1210	1210		10R	PB2Q8R	ASQ23R		
1221	1221	1201	450F	PB2Q7F		PB2Q7K	
2-TRACK STEREO RECORD/PLAY AND RECORD ONLY							
1800	1800	2000	800	B2H2K	TLA3L	PB2H2K	TLD53, TLDLH3
1801	1801	2001	400	B2H7K	TLA4L	PB2H7K	
1802	1802	2002	100	B2H4K	TLA5L	PB2H4K	
1803	2003		50R		TLA5R	PB2H4R	
1900	2000	1800	800	PB2H2K	TLA3L	B2H2K	
1901	2001	1801	400	PB2H7K	TLA4L	B2H7K	
1902	2002	1802	100	PB2H4K	TLA5L	B2H4K	
1903	2003		50R	PB2H4R	TLA5R		
1904	2010		10R	PB2H8R	TLA2R		
2000	2000	1800	800	PB2H2K		B2H2K	
2001	2001	1801	400	PB2H7K		B2H7K	
2002	2002	1802	100	PB2H4K		B2H4K	
2003	2003		50R	PB2H4R			
2007	2007		200	PB2H6K		B2H6K	
2010	2010		10R	PB2H8R			
2021	2021	2001	450F	PB2H7F		PB2H7K	
2047	2047			PB2H47K	TLA54L		
2-TRACK MONO RECORD/PLAY AND RECORD ONLY							
2600	2600	3200*	800	PB1HY2K	SLAH3L	PG1H2K*	SLA3L
2601	2601	3201*	400	PB1HY7K	SLAH4L	PG1H7K*	SLA4L
2602	2602	3202*	100	PB1HY4K	SLAH5L	PG1H4K*	SLA5L
2603	2603	3203*	50R	PB1HY4R	SLAH5R	PG1H4R*	SLA5R
2610	2610		10R	PB1HY8R	SLAH2R		
2700	2600	3200*	800	PB1HY2K	SLAH3L	PG1H2K*	
2701	2601	3201*	400	PB1HY7K	SLAH4L	PG1H7K*	
2702	2602	3202*	100	PB1HY4K	SLAH5L	PG1H4K*	
2703	2603	3203*	50R	PB1HY4R	SLAH5R	PG1H4R*	
2704	2610		10R	PB1HY8R	SLAH2R		
3000	3000	3200	800	G1H2K	SLS1L	PG1H2K	SLS2L
3001	3001	3201	400	G1H7K	SLS3L	PG1H7K	
3002	3002	3202	100	G1H4K	SLS4L	PG1H4K	
3100	3100		1000	GMH1L	GMH1L	G1HY2K	SCS2L, SCS1L
3101	3101		400	GMH3L	GMH3L	G1HY7K	SCS3L
3200	3200	3000	800	PG1H2K	SLAH3L	G1H2K	
3201	3201	3001	400	PG1H7K	SLAH4L	G1H7K	
3202	3202	3002	100	PG1H4K	SLAH5L	G1H4K	
3203	3203		50R	PG1H4R	SLAH5R		
3205	3205		200R	PG1H7R	SLAH4R		
FULL-TRACK RECORD/PLAY AND RECORD ONLY							
4000	4100		250	SLF3L		SLFH3L	
4001	4101		50R	SLF4R		SLFH4R	
4002	4102		100	SLF4L		SLFH4L	
4100	4100		250	SLFH3L	SLFH3L	SLF3L	
4101	4101		50R	SLFH4R	SLFH4R	SLF4R	
4102	4102		100	SLFH4L	SLFH4L	SLF4L	
4103			10R	SLFH7R16	SLFH7R		
4-CHANNEL RECORD/PLAY AND RECORD ONLY							
5600	5602		90	BQQ4K		BQQ4L	
5601	5601		50R	BQQ4R			
5602	5602		90	BQQ4K			
5603	5603		360	BQQ3K			
5604	5604		12R	BQQ23R			
3-CHANNEL RECORD/PLAY AND RECORD ONLY							
5701	5701		400	PB3Q7K			
5702	5702		100	PB3Q4K			
5703	5703		50R	PB3Q4R			
5707	5707		200	PB3Q6K			
5710	5710		10R	PB3Q8R			

ORIGINAL DISTRIBUTOR HEAD NUMBER	CURRENT DISTRIBUTOR HEAD NUMBER	ERASE VOLTAGE 60 KC	R/P INDUCTANCE WHY "R" HAS RECORD GAP	CURRENT O.E.M. EQUIVALENT MODEL NUMBER	ORIGINAL O.E.M. MODEL NUMBER	ALTERNATE AND CURRENT O.E.M. MODEL NUMBER	OBSOLETE AND DISCONTINUED MODEL NUMBER
4-TRACK STEREO COMBO							
6000	6000	115V	400	PA2Q17K			
6001	6001	115V	50R	PA2Q14R			
6002	6002	40V	400	PA2Q47K			
6003	6003	6V	800	A2Q22K			
6004	6004	40V	50R	PA2Q44R			
6005	6005	40V	200	VA2Q46K			
6009	6009	40V	800	A2Q42N2			
4-TRACK MONO COMBO							
6025	6025	6V	800	A1QC22K			
6026	6026	40V	400	A1QC47K			
2-TRACK STEREO COMBO							
6100	6100	40V	400	PA2H47K			
6101	6101	40V	50R	PA2H44R			
2-TRACK MONO COMBO							
6125	6125	115V	1200	A1HC11K			
6126	6126	40V	50R	PA1HC44R			
6127	6127	40V	400	PA1HC47K			
6128	6128	40V	200	VA1HC46K			

SMALL CASE DISTRIBUTOR HEAD NUMBER	SPECIAL LARGE CASE DISTRIBUTOR HEAD NUMBER	ERASE VOLTAGE 60 KC	SMALL CASE O.E.M. NUMBER **ADD "N9"	LARGE CASE O.E.M. MODEL NUMBER	OBSOLETE AND DISCONTINUED MODEL NUMBER
4-TRACK STEREO ERASE					
1400	1400L	115V	SEQ1**	SEQ1	SE50-1
1401	1401L	40V	SEQ4**	SEQ4	SE50-4
1402	1402L	6V	SEQ2**	SEQ2	SE50-2
1403		25V	SEQ9**	SEQ9	
2-TRACK STEREO ERASE					
2200	2200L	115V	SEH1**	SEH1	SE100-2
2201	2201L	40V	SEH4**	SEH4	SE100-4
2202	2202L	6V	SEH2**	SEH2	
2203		25V	SEH9**	SEH9	
2-TRACK MONO ERASE					
3600	3600L	115V	MEH1**	MEH1	ME100-2
3601	3601L	40V	MEH4**	MEH4	ME100-4
3602	3602L	6V	MEH2**	MEH2	
FULL TRACK ERASE					
4400	4400L	115V	MEF1**	MEF1	
4401	4401L	40V	MEF4**	MEF4	

PREMIUM HEADS

OBSOLETE HEADS

AVAILABLE ONLY IN NO MOUNT STYLE

ALL DISTRIBUTOR HEADS LISTED ARE NO MOUNT STYLES.

ALL O.E.M. HEADS LISTED ARE THE BASIC O.E.M. HEAD NOMENCLATURE.

O.E.M. HEAD NUMBERS	DISTRIBUTOR HEAD NUMBERS
NO MOUNT HEADS	
"N" suffix designates No Mount (see exception **).	See above.
REAR MOUNT HEADS	
"R" suffix designates Rear Mount.	Add 50 to No Mount Head number. Example: Head No. 1000 becomes 1050; 1234 becomes 1284.
SIDE MOUNT HEADS	
"S" suffix designates Side Mount.	Requires Quik-Kit (see table of mounting styles - page 3).
BASE MOUNT HEADS	
"B" suffix designates Base Mount.	Requires Quik-Kit (see table of mounting styles - page 3).

*ELECTRICALLY IDENTICAL BUT DIFFERENT SIZE CASE. MAY BE USED AS REAR MOUNT WHEN APPLICABLE.

**ADD "N9" TO DESIGNATE NO MOUNT.

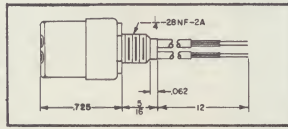


Record/Play and Record Only Heads

4-Tr. Stereo	2-Tr. Stereo	2-Tr. Mono	2-Tr. Mono	2-Tr. Mono	Full Track	4-Channel	3-Channel
1000 THRU 1049 1200 THRU 1249	1800 THRU 1849 2000 THRU 2049	2600 THRU 2649	3000 THRU 3049 3200 THRU 3249	3100 THRU 3149	4100 THRU 4149	5600 THRU 5649	5700 THRU 5749

All heads shown above are No Mount styles. Rear Mount styles are also available. Simply add 50 to the number to denote Rear Mount style (ie: 1000 is No Mount—1050 is same head with Rear Mount). See illustration to the right which shows details of the Rear Mount.

REAR MOUNT R/P



NEW HYPERBOLIC FACE

Available on most R/P heads. Gives improved tape to gap contact on recorders not requiring pressure pads, but can be used with pressure pads as well.

MINIATURE

AVAILABLE with Rear 1/4 x 2-56 Stud only R/P 4950 thru 4999 Er. 5350 thru 5399



Nortronics Model No.	Head Description	Head Function	Application (See Notes)	1 KC Inductance MHY	1 KC Impedance OHMS	DC Resistance OHMS	Net Each (No Mount)
1000 1001 1002	Standard 4-Track Stereo Hyperbolic Metal Face Laminated Cores	Record/Play Record/Play Record/Play	1 3 6	800 400 100	5000 2500 650	700 390 90	\$21.00 21.00 21.00
1200 1201 1202 1203 1205 1207	Premium 4-Track Stereo Hyperbolic Metal Face Laminated Cores	Record/Play Record/Play Record/Play Record/Play Record/Play Record/Play	1 3 6 8 4 5	800 400 100 50 200 200	5000 2500 650 400 1300 1300	700 390 90 90 390 200	\$28.20 28.20 28.20 28.20 28.20 28.20
1800 1801 1802	Standard 2-Track Stereo Hyperbolic Metal Face Laminated Cores	Record/Play Record/Play Record/Play	1 3 6	800 400 100	5000 2500 650	720 410 130	\$23.30 23.30 23.30
2000 2001 2002 2003 2007	Premium 2-Track Stereo Hyperbolic Metal Face Laminated Cores	Record/Play Record/Play Record/Play Record/Play Record/Play	1 3 6 8 5	800 400 100 50 200	5000 2500 650 320 1300	720 410 130 70 245	\$30.30 30.30 30.30 30.30 30.30
2600 2601 2602 2603 2630	Premium 2-Track Mono Hyperbolic Metal Face Laminated Cores Track .040 Off Center	Record/Play Record/Play Record/Play Record/Play Record/Play	1 3 6 8 7	800 400 100 50 10	5000 2500 650 320 70	400 165 70 14 15.90	\$15.90 15.90 15.90 15.90 15.90
3000 3001 3002	Standard 2-Track Mono Hyperbolic Metal Face Laminated Cores	Record/Play Record/Play Record/Play	1 3 6	800 400 100	5000 2500 650	400 165 70	\$ 8.40 8.40 8.40
3100 3101	2-Track Mono (Center Track) Cylindrical Metal Face Solid Cores	Record/Play Record/Play	1 3	1000 400	6300 2500	625 350	\$ 8.40 8.40
3200 3201 3202 3203 3205	Premium 2-Track Mono Hyperbolic Metal Face Laminated Cores	Record/Play Record/Play Record/Play Record/Play Play Only	1 3 6 8 4	800 400 100 50 200	5000 2500 650 320 1300	400 165 70 15.90 370	\$15.90 15.90 15.90 15.90 15.90
4100 4101	Premium Full-Track Hyperbolic Face Laminated Cores	Record/Play Record/Play	3 8	250 55	1500 330	200 125	\$34.70 34.70
— 4950	Miniature	Record/Play	6	40	250	125	\$14.00*
5601 5602 5603	4-Channel Hyperbolic Metal Face Laminated Cores	Record/Play Record/Play Record/Play	6 8 3	50 90 370	320 600 2200	150 170 690	\$99.00 99.00 99.00
5701 5702 5703 5707	Premium 3-Channel Hyperbolic Metal Face Laminated Cores	Record/Play Record/Play Record/Play Record/Play	3 6 8 5	340 100 50 200	2000 650 400 1300	800 260 260 99.00	99.00 99.00 99.00 99.00

Note: Add \$1.50 for Rear Mount except on 4950. Add \$.00 for Rear Mount on 5650 and 5750 series. * (Rear Mount)

"Combo" Heads

4-Tr. Stereo	4-Tr. Mono	2-Tr. Stereo	2-Tr. Mono
6000 THRU 6024	6025 THRU 6049	6100 THRU 6124	6125 THRU 6149

Nortronics Model No.	Head Description	Head Function	Equivalent Head Specification Reference	Net Each
6000 6001 6002 6003 6009	4-Track Stereo "Combo" Metal Face	Erase, Record/Play Erase, Record/Play Erase, Record/Play Erase, Record/Play Erase, Record/Play	Record/Play 1201 Erase 1400 Record/Play 1201 Erase 1400 Record/Play 1000 Erase 1402 Record/Play 1009 Erase 1401	\$33.00 33.00 33.00 33.00 33.00
6025 6026	4-Track Mono "Combo" Metal Face, Center Track	Erase, Record/Play Erase, Record/Play	Record/Play 1000 Erase 1402 Record/Play 1001 Erase 1401	\$18.00 18.00
6100	2-Track Stereo "Combo" Metal Face	Erase, Record/Play	Record/Play 2001 Erase 2201	\$36.00
6125	2-Track Mono "Combo" Metal Face, Center Face	Erase, Record/Play	Record/Play 2601 Erase 3601	\$21.00

ERASE HEAD SPECIFICATIONS

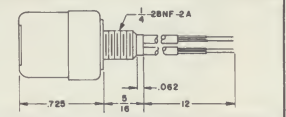
Nortronics Standard Model No.	Head Description	Special Case Styles Available	Impedance Description	1 KC Inductance MHY	60 KC Impedance OHMS	Operating Erase Current MA	DC Resistance OHMS	60 KC Operating Voltage VOLTS	Net Each
1400 1401 1402	4-Track Stereo Erase Full Metal Face	B Case, L Case B Case, L Case B Case, L Case	Hi Med Lo	80 10 0.13	30,000 2,800 40	3-5 10-15 80-140	270 40 2	90-150 28-42 3-6	\$12.00 12.00 12.00
2200 2201	2-Track Stereo Erase Full Metal Face	B Case, L Case B Case, L Case	Hi Med	80 8	25,000 2,000	4.5-7.0 16-24	205 35	100-150 32-48	12.00 12.00
3600 3601	2-Track Mono Erase Full Metal Face	B Case, L Case B Case, L Case	Hi Med	80 8	25,000 2,000	4.5-7.0 16-24	205 35	100-150 32-48	\$ 8.00 8.00
4400 4401	Full-Track Mono Erase Full Metal Face	B Case, L Case —	Hi Med	40 3.6	12,000 1,000	10-15 32-48	88 25	25-35 32-48	\$14.00 14.00
— 5350	Miniature	—	Med	5	1,200	28-42	38	32-48	\$12.00*

Note: L Case Heads—Same Prices as shown above. B Case Heads—Prices are double those shown above. (Rear Mount) All specifications subject to change without notice. *For 60 db erase of saturated tape. Voltages shown are RMS. Note: Add \$1.50 for Rear Mount except 5350

Erase Heads

4-Tr. Stereo	2-Tr. Stereo	2-Tr. Mono	Full Track
1400 THRU 1449	2200 THRU 2249	3600 THRU 3649	4400 THRU 4449

All heads shown above are No Mount styles. Rear Mount styles are also available. Simply add 50 to number to denote Rear Mount style (ie: 1400 is No Mount—1450 is same head with Rear Mount). See illustration at right which shows details of the rear mount.



REAR MOUNT ERASE

SPECIAL ERASE CASE STYLES AVAILABLE





■ Tape Recording Accessories



UNIVERSAL MOUNTS

QUICK-KIT 74 Adjustable Head Mounting Assembly. Unique design permits alignment of head for height, tilt and azimuth. Two TG-7 Guide Posts can be added if desired; if space does not permit, tabs for guide posts can be snapped off. Base has hole for mounting on recorder. For all Nortronics no mount Record, Record/Play and Erase heads.

- Play or Record/Play heads except 3000 thru 3299 Series and miniature heads. Base Size (with tabs): 1 1/16" W, 1 7/32" L. Without tabs: 1 1/16" W, 1 7/32" L. Net Each **\$2.25**
- QUICK-KIT 77 Adjustable Head Mounting Assembly.** Identical to Quik-Kit 74 (including dimensions) but for no mount heads in 3000 thru 3299 Series. Net Each **\$2.25**
- QUICK-KIT 78 Adjustable Head Mounting Assembly.** Identical to Quik-Kit 74 (including dimensions) but for no mount erase heads. Net Each **\$2.25**
- L-5, L-Bracket** for side-mount heads. Net Each **\$.50**
- L-6, As above** but with narrow base. Net Each **\$.70**
- L-7, Identical** to L-6 with reverse orientation to the bracket. Net Each **\$.70**

TAPE GUIDES

- TG-7, Tape Guide Post.** Vertically adjustable with tapped mounting hole in base. Chrome-Plated brass for long life. Net Each **\$1.00**
- TG-8, Tape Guide Plate.** For Side-Mount heads and L-5, L-6 or L-7 bracket; gives additional guiding. Net Each **\$.50**



ALIGNMENT TAPE

AT-100 Azimuth and Amplifier Alignment Tape. A 7.5 IPS full track, direct oscillator master recording of frequencies from 40 to 10,000 cycles for checking azimuth and NAB equalization. 1000 cycle zero reference level tone included. Instructions are included. Net Each **\$4.95**

CONNECTOR ASSEMBLIES

- CC-70—18"** plug and shielded insulated cable assembly for Nortronics heads (Except Mono Combo). Net Each **\$2.00**
- CC-77—18"** plug and shielded insulated cable assembly for Nortronics Mono Combo heads. Net Each **\$2.00**

BIAS OSCILLATOR TRANSFORMERS

T60-T2—For transistor circuits. Features Ferroxcube E-cores for high Q, maximum efficiency and distortion-free waveform. Supplies 40-120 volts at 60-100 KC. With instructions. Net Each **\$4.50**

- T60E—For** vacuum tube circuits, push-pull erase and bias power at operating frequencies from 40-70 KC; 120 volts rms to high impedance erase heads and 7 volts rms to low impedance erase heads. With instructions. Net Each **\$4.50**
- T60F—For** vacuum tube circuits, push-pull erase and bias power at operating frequencies from 70-100 KC; output 150 volts rms tapped at 60 volts for high and medium impedance erase heads. With instructions. Net Each **\$4.50**

■ Conversion Kits

For older Revere & Wollensak Models

- WR-30—Converts** all monophonic Wollensak and Revere tape recorders to full-track Record/Play. Fully assembled. Net Each **\$57.00**
- WR-35—Retains** monophonic Record/Play capabilities—converts 2-track stereo to 4-track stereo Play. Fully assembled. Net Each **\$25.50**
- WR-40—Converts** monophonic machines to monophonic Record/4-track stereo Play. Fully assembled. Net Each **\$32.50**
- WR-60—Positive** shifter provides four-channel monophonic Record/Play, 2 and 4-track stereo Erase/Record (requires additional second channel record pre-amp). Complete fully assembled. Net Each **\$49.50**

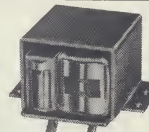
■ **Special Quik-Kits.** A Nortronics Quik-Kit is a package of hardware with complete instructions for making an installation of a Nortronics tape head on a recorder. Most Quik-Kits are universal in design to fit on most recorders. The Special Quik-Kits are designed to make installation on those recorders requiring a mount that is unique to that type of machine only.

QK	Make	Function	Model Nos.	Net Each
100	PENTRON	R/P	CT-1, HF-400, HT-225, MP-2, NL-1, NL-2, NL-3, PMC, PMD-1, PT-W3, PT-1, PT-72, PT-74, RWN, T-90, TM-1, TM-56, TR-4, TR-10, 9T3C, 9T3M, PB-A2, PB-1	\$ 2.00
300	PENTRON	Erase	CT-1, HF-400, HT-225, MP-2, NL-1, NL-2, NL-3, PMC, PMD-1, PT-W3, PT-1, PT-72, PT-74, RWN, T-90, TM-1, TM-56, TR-4, TR-10, 9T3C, 9T3M, NL-1S, NL-2S, NL-3S, PT-1S, PT-W3S, PT-72S, PT-74S, TM-4	\$ 2.25
101	BELL & HOWELL	R/P & Erase	600, 770, 775-G10 (Serial # ABOVE 2702)	\$ 4.25
102	SONY	R/P	101, 262-D, 262-SL machines and all Sony decks.	\$ 1.75
301	SONY	Erase	262-D machines and all Sony decks.	\$ 1.75
103	RCA & BELL SOUND	R/P	RCA 1YB11, 1YB26, 1YC11. Bell 601, 603	\$ 1.00
106	CONCERTONE	R/P	20/20, 30/30, 60 Series	\$12.00
304		Erase		\$12.00
82	TANDBERG	R/P	60, 64, 65, 74	\$ 2.00

■ **Special Head-Kits—**For some recorders the replacement heads and hardware are unique to those recorders alone. Nortronics, therefore, provides Special Head-Kits which contain all of the necessary heads, hardware and instructions to make a complete installation on these certain recorders.

HK	Make	Function	Model Nos.	Net Each
RP-1	RECORDIO	R/P	2A10 (late), 2A10B, 2A11, 2A11B	\$ 9.90
RP-2	REVERE & WOLLENSAK	R/P	Revere T-11-4, T-204-4, T-2200, TS-2205, TS-2225. Wollensak T-1515-4, T-1616-4, T-1818, T-1580	\$22.60
RP-4	WEBCOR	R/P	2202, 2202-1, 2205, 2205-1, 2300	\$12.00
RP-5	WEBCOR	R/P	2001, 2009, 2206-1, 2810, 2811, 2812, 2816, 2819, 2891, 2892, 2896, 2910, 2919, 2820, 2820-1C, 2821, 2822, 2827, 2897, 2923, 2950, 2955	\$12.50
RP-6	WEBCOR	R/P	For R/P Mono and Play Stereo—2820, 2820-1C, 2821, 2822, 2827, 2897, 2923, 2950, 2955	\$23.80
RP-8	SILVERTONE	R/P	7065, 7066, 7076, 7080, 7081, 9076	\$26.30
RP-9	SILVERTONE	R/P	6074, 7074, 8074	\$18.90
E-50	REVERE & WOLLENSAK	Erase	All 4-Track Mono	\$11.00
E-51	WEBCOR	Erase	All 4-Track Stereo	\$12.50
E-52	REVERE & WOLLENSAK	Erase	All 4-Track Stereo except Wollensak T-1580	\$16.25
E-53	SONY	Erase	262D, 262SL	\$15.25
E-54	SONY	Erase	101	\$11.25
E-57	LUXOR	Erase	NP-410A	\$15.25
E-58	WEBCOR	Erase	All old 2-Track Mono	\$ 8.00
E-59	WOLLENSAK	Erase	T-1580	\$17.75
RPE-20	REVERE & WOLLENSAK	R/P & Erase	Direct replacement for most older model monophonic machines having a Record/Play and Erase Assembly. Complete assembly mounted on special plate, wired and ready to install.	\$15.60

RPE-23 & RPE-24—These Nortronics Head-Kits are designed as premium quality replacements for several Shure "combination" heads originally developed in the early years of tape recording. They are called combination heads because the Erase and Record/Play functions (normally two separate heads) were contained in a single assembly and mounted as if they were one head. For specific replacements, see the table below. RPE-23 will fit the same models as the RPE-20 plus the very old model Revere & Wollensak monophonic machines.



RPE-23
RPE-24

■ Cross-Reference for Robins-Michigan/Magnetics and Shure Bros. Tape Heads

Nortronics Model No.	Quik-Kit No.	Description	Net Ea.* (Not including QK)
1851	—	ROBINS-M/M Type	
1801	66	3F20-101	\$24.80
3251	—	3F20-105	23.30
3001	20	3FM20-104, 3FM20-108	17.40
1800	38	3L20	8.40
1000	38	5B20LS, 7B17, 10B20LS	23.30
1000	103	5Q17, 5Q17-105	21.00
3000	20	5Q17, 5Q17-105	21.00
3601	18	7L17, 7L17-108, 10L17-104	8.40
2201	18	5S1, 5S1-103, 7EM12A	8.00
1401	18	5SS1	12.00
3600	18	9QE3	12.00
6002	38	40EM12	8.00
		5AV17	33.00
RPE-23	—	ROBINS-SHURE Type	
		5TRB	\$15.60
RPE-23	—	SHURE BROTHERS Type	
		815, TR5B, TR5B-J, TR5D, TR5N, TR6H	\$15.60
RPE-24	—	815H, TR5C, TR5K, TR5L, TR5Z-2, 816, TR5Z2-J	15.60
3101	20	817, TR16A, TR21C, TR21B, TR21A, TR16-J	8.40

*Quik-Kit numbers, when shown, indicate additional required mounting hardware. Order separately, using ADDITIONAL MOUNTING STYLES TABLE on opposite page.



FREE! TAPE HEAD REPLACEMENT GUIDE

By Nortronics. Specifies replacement for 440 Tape Recorders by Manufacturer and Model Number. See your local Nortronics Distributor or write to Nortronics. **FREE!**



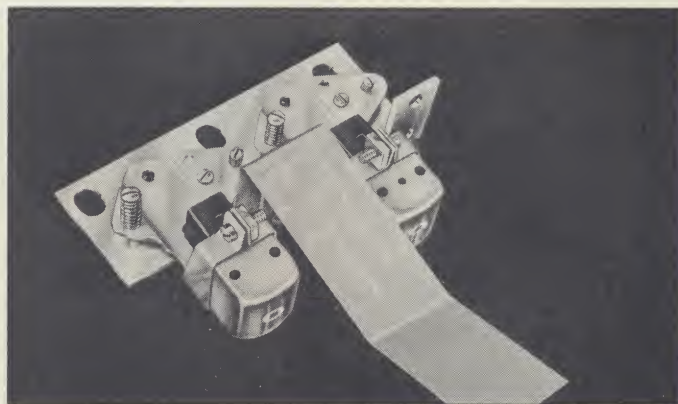
■ No-Mount Head Bracket Assembly for Cartridge Machines

QK-114 installs two no-mount dual channel heads for monophonic use or two no-mount three channel heads for stereo operation. The left head is for recording. The right head is for playback. Requires heads similar to 2000 series. Completely assembled—Semi aligned.....Net Each **\$13.60**

QK-115 installs two no-mount monophonic 2-Track heads (see monitor conversion information below). Requires heads similar to 3000 series. Completely assembled—Semi aligned. Net Each **\$13.60**

QK-117 installs one no-mount monophonic head and one no-mount dual channel head, and provides the advantages of monitoring program material during recording. Requires one head similar to 3000 series and one head similar to 2000 series. The left head is a special monophonic record-only head with a 500 micro-inch gap for optimum recording of the upper program channel. The right head is a dual channel Record/Play head. The upper channel monitors and plays the program signal. The lower channel records and plays the cue tone. (See shaded columns in table below for these monitor conversions). Completely assembled—Semi aligned. Net Each **\$13.60**

ALL MODELS COME COMPLETE WITH CARTRIDGE HOLD-DOWN SPRING AND CARTRIDGE GUIDE RAIL



■ Replacement Head Listing for Cartridge Machines

QK-115 TYPE

MANUFACTURER AND MODEL NO.		NO MOUNT HEADS		REAR MOUNT HEADS	
		USE WITH QK-114, 115, 117 OR ON MACHINES USING SIMILAR TYPE HEAD BRACKETS.		CANNOT BE USED WITH QK-114, 115, 117.	
		NOTE: Select Quik-Kits from table at bottom.		CONVERSION TO MONITOR OPERATION	
ATC	P150, P190, PB150, PB190, PC150, PC190	3201 Program Record Play ¹	3205 Program Record ²	3255 Program Record ³	3251 Program Record Play ⁴
		3200 Cue Record Play ¹	2000 Program Play & Cue R/P ²	2050 Program Play & Cue R/P ³	3250 Cue Record Play ⁴
	CP11, CP12, CP13 Mono CP21, CP22, CP23 Stereo	2003 Program Cue Record			2053 Program Cue Record
		2007 Program Cue Play			2057 Program Cue Play
		5703 Program Cue Record			5753 Program Cue Record
		5707 Program Cue Play			5757 Program Cue Play
COLLINS	PB150, PB190, P150, P190	3201 Program Record Play ⁵	3205 Program Record ⁶	3255 Program Record ⁷	3251 Program Record Play ⁸
		3200 Cue Record Play ⁵	2000 Program Play & Cue R/P ⁶	2050 Program Play & Cue R/P ⁷	3250 Cue Record Play ⁸
	642 A-1, 642 A-2	3201 Program Record Play ⁹	3205 Program Record ⁹	3255 Program Record ¹⁰	3251 Program Record Play ¹⁰
		3200 Cue Record Play ⁹	2000 Program Play & Cue R/P ⁹	2050 Program Play & Cue R/P	3250 Cue Record Play ¹⁰
GATES	M5944	3201 Program Record Play	3205 Program Record	3255 Program Record	3251 Program Record Play
		3200 Cue Record Play	2000 Program Play & Cue R/P	2050 Program Play & Cue R/P	3250 Cue Record Play
	M6211 (Play Only)	2002 Program Cue Play ¹¹			2052 Program Cue Play ¹²
		2002 Program Cue Record ¹¹			2052 Program Cue Record ¹²
	M6213C	2002 Program Cue Play ¹¹			2052 Program Cue Play ¹²
		2002 Program Cue Record ¹¹			2052 Program Cue Record ¹²
	M6212 (Play Only)	5701 Program Cue Play ¹³			5751 Program Cue Play ¹⁴
		5703 Program Cue Record ¹³			5753 Program Cue Record ¹⁴
	M6214C	5701 Program Cue Play ¹³			5751 Program Cue Play ¹⁴
		5703 Program Cue Record ¹³			5753 Program Cue Record ¹⁴
KRS	M5735 (Spot Tape)	Erase: 3600B and Nortronics Mount QK-35 R/P: 2601 and Nortronics Mount QK-35			
	REAR MOUNT HEADS	MUST BE USED. Check original Nortronics head number and select replacement from this listing: SLAH4L (#3251), SLAH5L (#3252), TLAH4L (#2051), TLAH5L (#2052), TLAH5R (#2053), PB2H4R (#2053), PB2H7K (#2051).			
MACARTA (MOULIC SPECIALTIES)	105/108 Playback	3201 Program Play			3251 Program Play
	2405/2408 Carousels	3201 Cue Play			3251 Cue Play
	560 Recorder		3205 Program Record	3255 Program Record	
			2000 Program Play & Cue R/P	2050 Program Play & Cue R/P	
	500 Playback (transistor), 248 Carousel (transistor)	2000 Program Cue Play			
	570 Record Playback (transistorized)	2003 Program Cue Record			
RCA	208 Stereo Playback	2000 Program Cue Play			
	RT 7A	Special—Requires 2 Nortronics #1201 heads plus a QK-114			
	RT 7A CUE HEAD IS ON LEFT. PROGRAM HEAD IS NEXT TO CAPSTAN.	3201 Program Record Play	3205 Program Record	3255 Program Record	3251 Program Record Play
	RT 7B, RT 7C	3201 Cue Record Play	2001 Program Play & Cue R/P	2051 Program Play & Cue R/P	3251 Cue Record Play
	RT 7B, RT 7C CUE HEAD IS ON LEFT. PROGRAM HEAD IS NEXT TO CAPSTAN.	3202 Program Record Play	3202 Program Record		3252 Program Record Play
		3201 Cue Record Play	2047 Program Play & Cue R/P ¹⁵		3251 Cue Record Play
	RT 17 Mono				2052 Program Cue Record
	QUICK KIT CONVERSION TO NO MOUNT HEADS NOT RECOMMENDED.				2052 Program Cue Play
	RT 37 Stereo				5752 Program Cue Record
	QUICK KIT CONVERSION TO NO MOUNT HEADS NOT RECOMMENDED.				5752 Program Cue Play
SPARTA	200RP, 200P, 300P	3201 Program Record Play	3205 Program Record	3255 Program Record	3251 Program Record Play
		3200 Cue Record Play	2000 Program Play & Cue R/P	2050 Program Play & Cue R/P	3250 Cue Record Play
	400RP	2003 Program Cue Record			
	400P	2001 Program Cue Play			
SPOTMASTER	Older models used a wide variety of heads and often require circuit changes to match the newer heads to the electronics. It is advisable to contact the manufacturer for information.				
TAPECASTER	600RP,	3201 Program Record Play	3201 Program Record	3251 Program Record	3251 Program Record Play
	600P (A and E Only)	3200 Cue Record Play	2000 Program Play & Cue R/P	2050 Program Play & Cue R/P	3250 Cue Record Play

NOTE: Older vacuum tube models will take the same heads listed.

- USE QK-114 WITH "B" SIZE: NO MOUNT SERIES 1000, 1200, 1800, 2000, 4100, 5600 & 5700 HEADS
- USE QK-115 WITH "G" SIZE: NO MOUNT SERIES 3000 & 3200 HEADS
- USE QK-117 WITH "B" SIZE: NO MOUNT SERIES 1000, 1200, 1800, 2000, 4100, 5600 & 5700 HEADS
- USE QK-117 WITH "G" SIZE: NO MOUNT SERIES 3000 & 3200 HEADS

TO CONVERT TO QK-117

QK-112 BRACKET CONVERTS QK-115 TO QK-117—Net Each \$2.70
QK-113 BRACKET CONVERTS QK-114 TO QK-117—Net Each \$2.70

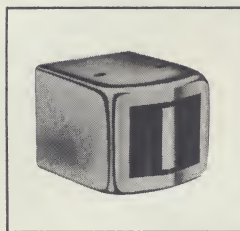
Nortronics



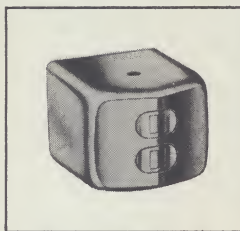
FOR PROFESSIONAL MACHINES

REPLACEMENT HEAD LISTING HEAD MOUNTING BRACKETS

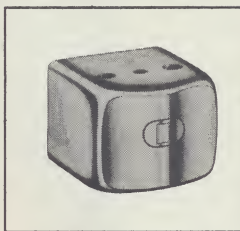
■ Replacement Head Listing for Professional Machines



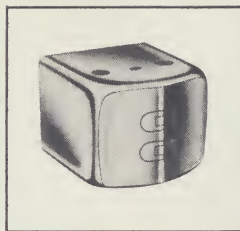
FULL TRACK R/P



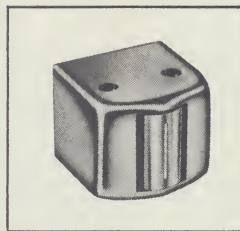
2-TRACK STEREO R/P



2-TRACK MONO R/P



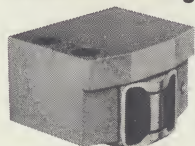
4-TRACK STEREO R/P



FULL TRACK ERASE

RECORDER MAKE	MODEL NUMBERS	ORIGINAL HEAD FUNCTION	NORTRONICS REPLACEMENT HEAD	QUIK KIT	HEAD NET PRICE
AMPEX	300, 350, 354, 400 Series PR-10, 600, 900, 1200 Type Series (These series all require QK-66 instead of QK-76)	Record, Full Track	8001	76	\$36.00
		Play, Full Track	8000	76	36.00
		Erase, Full Track (for all except 300 series)	8109	76	30.00
		Erase, Full Track (for 300 series only)	8106	76	30.00
		Record Mono, 2-Track	8401	76	22.00
		Play Mono, 2-Track	8400	76	22.00
		Erase Mono, 2-Track	8504	76	18.00
		Record Stereo, 2-Track	8201	76	32.00
	Play Stereo, 2-Track	8200	76	32.00	
	Erase Stereo, 2-Track	8304	76	26.00	
		3200	Record Stereo, 4-Track	8604	76
Play Stereo, 4-Track			8600	76	30.00
Erase Stereo, 4-Track			8701	76	26.00
Record, Full Track			8004	76	40.00
Record Stereo, 2-Track	8201	76	32.00		
Record Stereo, 4-Track	8604	76	30.00		
CROWN	701, 801, BX801, 1001, 1401	Play only or Record/Play, Full Track	8006	35	36.00
		Record, Full Track	8001	35	36.00
		Erase, Full Track	8104	35	30.00
	712, 822, BX822, 1022, 1422/8	Play only or Record/Play Stereo, 2-Track	8209	35	32.00
		Record Stereo, 2-Track	8201	35	32.00
		Erase Stereo, 2-Track	8304	38	26.00
	702, 802, BX802, 1002, 1402/8	Play only or Record/Play Mono, 2-Track	8403	35	22.00
		Record Mono, 2-Track	8401	35	22.00
		Erase Mono, 2-Track	8504	38	18.00
	A51, A314	Play only Mono, 2-Track	8403	66	22.00
A54, A324	Play only Stereo, 4-Track	8608	66	30.00	
714C, 824, BX824, 1024, 1424	Play only or Record/Play Stereo, 4-Track	8608	66	30.00	
	Record Stereo, 4-Track	8603	66	30.00	
	Erase Stereo, 4-Track	8701	38	26.00	
MAGNECORD	1021	Record, Full Track	8005	—	40.00
		Play, Full Track	8006	—	36.00
		Erase, Full Track	8102	—	30.00
		Play Mono, 2-Track (Optional, Not original equipment)	8408	—	22.00
	1022	Record Stereo, 2-Track	8203	—	35.00
		Play Stereo, 2-Track	8202	—	35.00
		Erase Stereo, 2-Track	8302	—	26.00
	1024	Record Stereo, 4-Track	8602	—	30.00
		Play Stereo, 4-Track	8607	—	30.00
		Erase Stereo, 4-Track	8702	—	26.00
	PT6, PT63 (For 3 head operation, only 1 QK-81 required)	Record or Play, Full Track	8007	81	36.00
		Erase, Full Track	8105	81	30.00
P60, P75, M90	Record or Play Mono, 2-Track	8407	81	22.00	
	Erase Mono, 2-Track	8506	81	18.00	
TAPE-A-THON	702	Record, Full Track	8001	35	36.00
		Play, Full Track	8000	35	36.00
		Erase, Full Track	8105	35	30.00
R.C.A.	RT21	Record/Play Mono, 2-Track	8405	—	18.00
		Record, Full Track	8002	—	68.00
		Play, Full Track	8003	—	54.00
		Erase, Full Track	8110	—	68.00
		Record Stereo, 2-Track	8206	—	42.00
		Play Stereo, 2-Track	8205	—	54.00
Erase Stereo, 2-Track	8307	—	48.00		

■ Head Mounting Brackets for Professional Machines

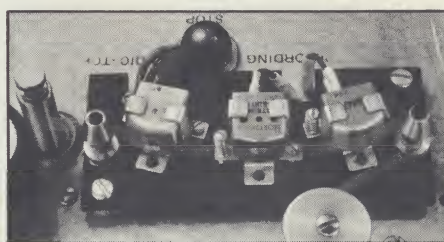


QK-76 WITH
NORTRONICS HEAD
MOUNTED IN PLACE

QK-76 is a neatly packaged kit containing all of the hardware and detailed illustrated instructions necessary to adapt a Nortronics head to the shield cup of an Ampex head nest. It consists of a precision cast aluminum block; spacers; screws; connector plug; and complete instructions. All other parts necessary are utilized from the original Ampex equipment.....Net Each **\$12.00**

QK-35 is a special base-mount bracket kit for adapting Nortronics no-mount heads for replacement of Brush heads or in any application requiring a large base mounting stud. (Stud— $\frac{1}{4}$ -.28 x $\frac{5}{16}$).....Net Each **\$2.00**

QK-66 is a standard base-mount bracket kit for adapting Nortronics no-mount heads for most base-mount applications. (Stud— $\frac{1}{8}$ -.32 x $\frac{5}{16}$).....Net Each **\$1.00**



QK-81 WITH 3 NORTRONICS HEADS
MOUNTED IN PLACE ON
MAGNECORD PT6 MACHINE

QK-38 is a standard side-mount bracket kit for adapting Nortronics no-mount heads for most side-mount applications. Net Each **\$1.00**

QK-81 is a completely assembled kit which allows conversion of the Magnecord PT6 and PT63 type machines to modern heads. The third head position can be used for monitor or stereo playback. Instructions are included to adapt the original Magnecord electronics to accept the new Nortronics heads and meet NAB standards on equalization. Response to 15 KC at 7.5 IPS and 10 KC at 3.75 IPS.

THE NORTRONICS COMPANY, INC. • 8101 TENTH AVE. NO. • MINNEAPOLIS, MINN. 55427 • PHONE: 612 — 545-0401

THE NORTRONICS COMPANY, INC. MINNEAPOLIS, MINNESOTA 55427

8101 TENTH AVENUE NORTH TELEPHONE 545 - 0401



MR. T. NELSEN
BOX 1546
POUGHKEEPSIE, NEW YORK 12603

Thank you for your recent inquiry and for your interest in NORTRONICS products.

We are enclosing descriptive literature on our general product line for your examination and use. Our factory representative in your area is listed below. He will be glad to supply you with any additional information that you may need.

If we can be of further assistance, please let us know. We are looking forward to being of service to you.

Sincerely,

THE NORTRONICS COMPANY, INC.

JOHN STAWICKI
Nortronics Representative
P.O. Box 126
Westbrook Road
Essex, Conn.
(203+767-8566)

J. F. Dundovic
Joseph F. Dundovic
Industrial Sales Manager

Nortronics

MAGNETIC TAPE HEADS



Nortronics®

CUSTOMER ENGINEERING BULLETIN

THE NORTRONICS COMPANY, INC. 8101 TENTH AVENUE NORTH MINNEAPOLIS, MINNESOTA 55427

HEAD WEAR, ALIGNMENT AND CARE

HEAD WEAR AND ALIGNMENT

When a tape recorder is properly designed, and when the tape guiding components (guides, head, pressure pads, capstan roller, reel plates, etc.) are properly adjusted and maintained, it is then--and only then--that the owner will get full performance characteristics from the magnetic recording process. Since even the use of premium quality tape will eventually wear the recording and erase heads, it is especially important to clean, maintain adjustment, and eventually replace heads when the electrical characteristics of the head are excessively altered by tape wear. The following information will be of interest to tape machine owners concerned with head wear and alignment.

TAPE-TO-HEAD CONTACT, TAPE GUIDING, AND ALIGNMENT

When the head gap is out of alignment in azimuth, or in other words when the gap is not perpendicular to the direction of tape motion, there can be a serious loss in high frequencies. This is especially true when the machine is called upon to play back a standard, pre-recorded tape that has been made on a recorder or duplicator with proper azimuth alignment. To illustrate the importance of azimuth alignment, if a fully aligned 7500 cycle per second tape is played back on a half-track machine at 7.5 inches per second, it will be found that an azimuth mis-alignment of only $1/3^\circ$ will reduce the playback signal to one-half of its proper level.

With this in mind the reader should also recognize that any skewing (vertical tape walk) resulting from wobbly reels or over-sized guides can easily cause a cyclic or random off-and-on state of azimuth alignment even if the head gap is aligned to the nominal tape position. This is shown in Fig. 3-1. If the plane of the face of the head is not aligned parallel to the tape guiding plane (see Fig. 3-2), a tendency to skew or "walk" will also result.

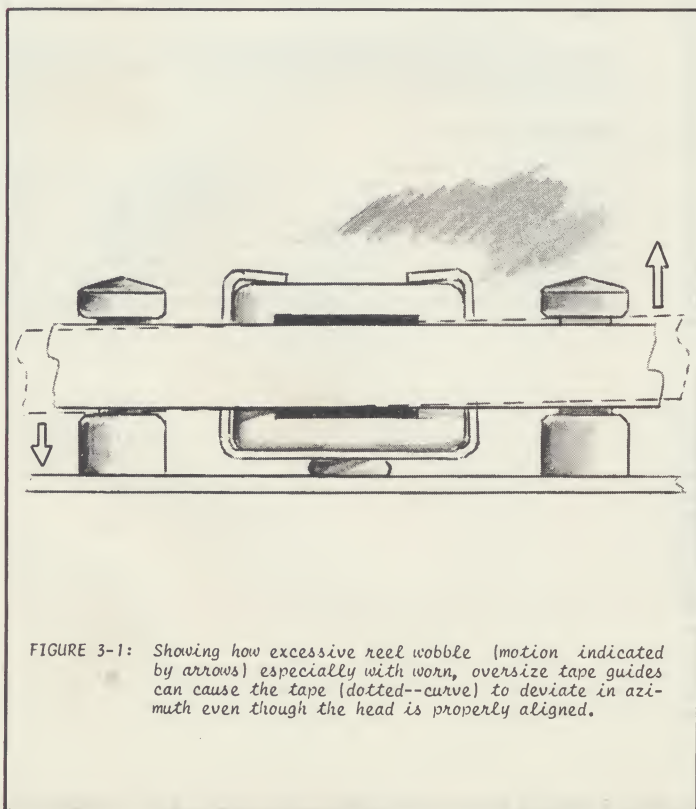


FIGURE 3-1: Showing how excessive reel wobble (motion indicated by arrows) especially with worn, oversize tape guides can cause the tape (dotted-curve) to deviate in azimuth even though the head is properly aligned.

PRESSURE PADS

As discussed in CEB number 1, many tape machine manufacturers choose to use fabric or felt pressure pads that apply pressure to the back (shiny side) of the tape at the area that is immediately in contact with the recording head gap. This is shown in Fig. 3-3. The pressure pad approach is a simple, effective, relatively inexpensive, and yet potentially troublesome method of obtaining intimate tape-to-head contact. One undeniable asset of the pressure pad lies in the fact that wrinkled, mistreated tape can generally be made to pass across the head gap and give satisfactory record and playback performance. An important liability is the fact that head wear is greatly accelerated and usually in a manner that results in unequal wear across the width of the head. This unequal wear is a result of the pad not providing uniform pressure across the width of the tape and

Angle of deviation
from true perpendicular

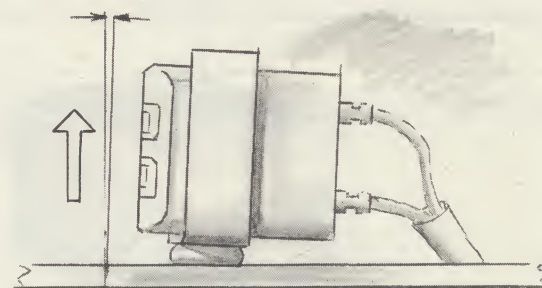


FIGURE 3-2: If head face plane is not parallel to true perpendicular, tape will tend to skew in direction of arrow.

it frequently causes craters or ripples to form in the head surface as shown in Fig. 3-4. It can cause the tape to lose contact with part or all of the head gap. Increased complications will result if oxide deposits build up in the craters.

Another detrimental condition results when a machine is equipped with a quarter-track stereo head that is mechanically moved up and down to place the head from the "quarter-track" to the "half-track" or centered position. In this case, unless the owner almost equally divides machine time between the two modes, a groove will wear in the head that corresponds to the track position that is favored. Again, if pressure pads are used, the grooves will be worn even faster into the head surface.

PERFORMANCE DETERIORATION

As the head wears, several changes occur in the operational characteristics. These changes take place on a gradual, continuing basis.

On record:

- (1). Peak bias current requirement decreases.
- (2). Inductance decreases.
- (3). Actual bias current increases.
- (4). Record sensitivity increases.
- (5). Record current slightly increases.
- (6). Gap linearity frequently decreases and finally the gap abruptly opens.

On playback:

(1). Playback sensitivity generally increases; high frequency response relative to low frequency response increases and then abruptly reverses as the gap opens.

In the record process, (1) and (3) aid each other to reduce high frequency

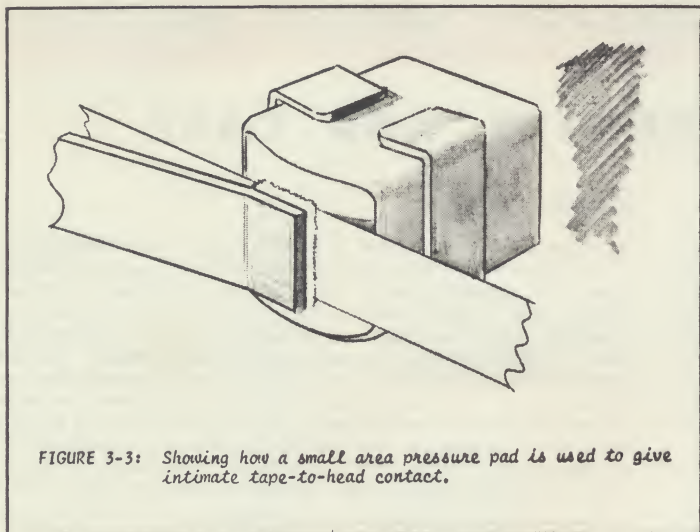


FIGURE 3-3: Showing how a small area pressure pad is used to give intimate tape-to-head contact.

system response by producing an over bias. In the case of many home machines, a bias control is not provided and the machine cannot be compensated for high frequency losses to maintain proper performance.

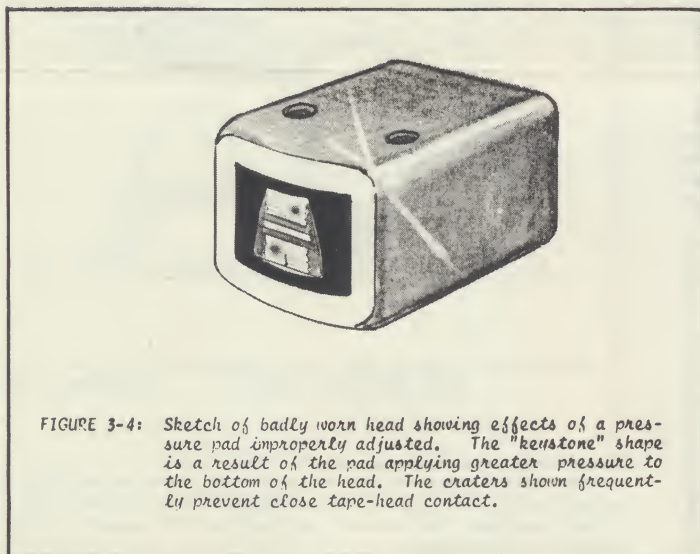


FIGURE 3-4: Sketch of badly worn head showing effects of a pressure pad improperly adjusted. The "keystone" shape is a result of the pad applying greater pressure to the bottom of the head. The craters shown frequently prevent close tape-head contact.

HEAD LIFE

Head life is highly dependent upon the design factors of the recorder involved. For example, the differences in head wear with and without pressure pads can sometimes be an order of magnitude (a factor of ten)! If a machine makes use of a relatively small area pressure pad, and if the pressure pad has an applied force of greater than one-half ounce, head life can be as low as 300 or 400 hours of recording or playback operation time. On the other hand, if a machine does not use pressure pads, and if the tape guides are smooth, and the depth of metal at the record gap is sufficiently large, 3000 to 4000 hours of operation can be expected. The table shown in Fig. 3-5 will provide an approximate guide to permit the machine owner to judge performance time before expecting to notice losses in performance from head wear. It must be pointed out that a premium tape from a reputable manufacturer will also greatly reduce problems from head wear. Of interest too is the fact that re-use of the same tape produces less abrasion on the tape head than an equal amount of time with "fresh" tape.

HEAD CARE

A magnetic tape head deserves the same attention that a high quality phonograph cartridge and needle assembly requires. The head core material is almost always made of a high nickel-content alloy steel. This material, called Mu metal, Hy Mu-80, etc. is annealed (heat treated) to provide maximum performance characteristics for magnetic recording. This process, unfortunately, reduces the core material to a state of mechanical "softness". In view of this, it is necessary that the tape recorder owner exercise caution in cleaning the head face. Specifically, lens paper

PRESSURE PADS	TAPE LIFTERS	DOMINANT SPEED 1.875 3.75 7.5	PROBABLE HEAD LIFE	COMMENTS
Yes	Yes		500-600 hrs	Life depends greatly upon such factors as condition of tape, make of head and even ambient dust and humidity . . .
Yes	No		300-400 hrs	
Yes	No	*	500-600 hrs	
Yes	No	*	700-800 hrs	
No	No		1000-2000 hrs	
No	Yes		2000-4000 hrs	

FIGURE 3-5: Table showing very approximate head wear figures for high-nickel alloy cores (laminated or single laminar) in a plastic or die-cast core holder. Special alloys such as Alfenol do not give satisfactory permeability for use as high performance magnetic heads even though it is somewhat "harder" mechanically.

or a cotton swab device such as a Q-Tip would be ideal for this operation. Pipe cleaners or any device such as a stiff bristle brush can easily ruin the magnetic head surface and should never be used.

The use of solvents for cleaning purposes should be restricted to those products that will not in any way react with the resins, plastic surfaces, or metal surfaces of the head. One recommended cleaner would be Long-Life. The Long-Life kit contains two separate products. First, a cleaning solution that contains several solvents to dissolve deposited oxide material, grease, and other foreign particles. The cleaner solution if used according to directions will not harm epoxy resin, core metals, face metals or plastic materials used in the head construction. This same cleaner should be used on the tape guides, capstan shaft, and pressure rollers; the solvents will not in any manner affect the characteristics of rubber or neoprene.

The second solution in the Long-Life kit is a silicon cleaner that will disperse a thin coat of lubricant by capillary action. A small pylon dispenser is included with the kit.

HEAD MAGNETIZATION

One of the most important factors in retaining low noise and good high frequency performance characteristics results from keeping recording heads thoroughly demagnetized. This can best be done by using a small head-demagnetizer designed specifically for this purpose. It usually has soft, plastic-coated tip which will adequately protect the head from being scratched or marred. Frequent demagnetizing by this means has a two-fold beneficial purpose: (a) Valuable recorded tapes will not be superimposed with recorded noise, and (b) high frequency playback performance of the machine will generally be enhanced.



Nortronics®

CUSTOMER ENGINEERING BULLETIN

THE NORTRONICS COMPANY, INC. 8101 TENTH AVENUE NORTH MINNEAPOLIS, MINNESOTA 55427

THE VACUUM TUBE PLAYBACK PREAMPLIFIER

GENERAL INFORMATION

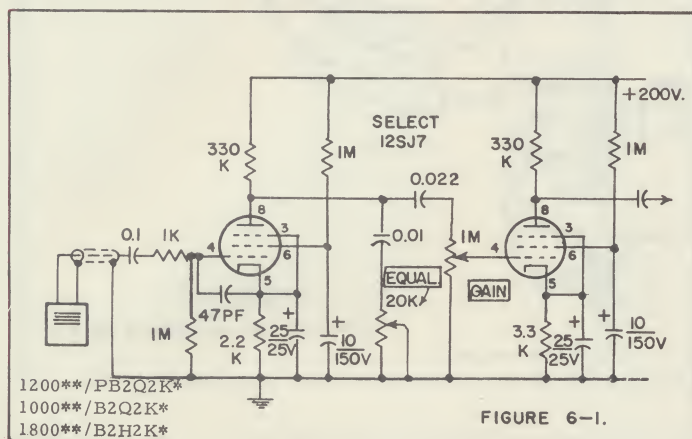
The vacuum tube still holds a predominant position in tape recorder amplification. This is due to the large amount of design experience that has been gained in vacuum tube circuits and also to the large number of inexpensive, low-noise tubes that are currently available to the designer.

The tape recorder preamplifier must be designed with the following points in mind:

- Signal-to-noise ratio must be as high as possible; on professional equipment, tape noise should be the limiting factor in the amplifier.
- Equalization should permit flat system response with a tape pre-recorded to NAB or similar standards.
- It should be stable, and if possible, feedback should be used to reduce gain variations due to tube aging.

THE PENTODE PREAMPLIFIER

The high gain, low-noise linear pentode has been used extensively in tape recording playback amplifiers. The schematic in Figure 6-1 shows a typical pentode unit designed for use with NAB playback equalization. The increased input impedance which is inherent in the pentode tube permits the designer to use very high inductance playback heads without degeneration at higher frequencies. The schematic shows a .01 capacitor and a 20 k potentiometer in a simple shunt equalizer. The value of the capacitor is chosen so that the absolute value of its capacitive reactance is equal to the effective pentode output impedance at a frequency which is between 20 and 60 cycles depending upon low frequency characteristics of the playback head being used. The value of the 20 k potentiometer is determined by the high frequency performance of the head, the tape speed being used, and so on. An NAB type curve is shown in Figure 6-2. This is repre-



sentative of the typical amplifier playback response at 7.5 inches per second. Since there is no feedback used in this amplifier, the overall gain of the amplifier will be directly affected by the condition of the tubes.

THE TRIODE PREAMPLIFIER

The amplifier shown in Figure 6-3 is a triode unit with the equalization applied in a feedback circuit from the plate of the second stage to the cathode of the first stage. A simple method of determining the value of the feedback parameters will be described: First, the gain of the two stage amplifier without feedback is determined at 1kc (this gain is shown in Figure 6-2 at A). A feedback network consisting of the 500k potentiometer and a large capacitor (0.1 mfd, for example) is connected in series between the second stage plate and the first stage cathode; the potentiometer is then adjusted until the gain is 35db below the open-loop gain (this is B in Figure 6-2). The 0.1 mfd capacitor is now experimentally reduced in value until the response at 1kc is 25 db below the open-loop gain (this is C in Figure 6-2).

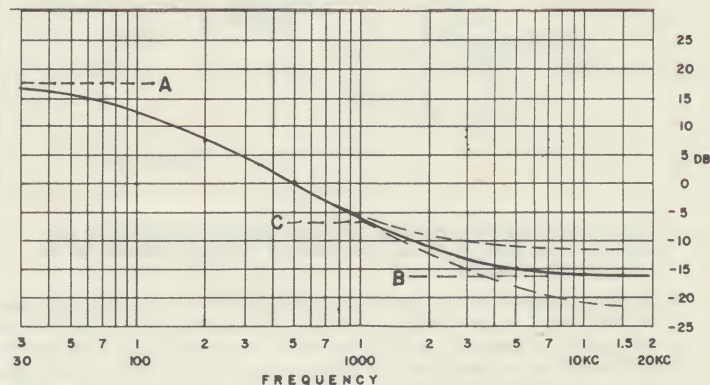
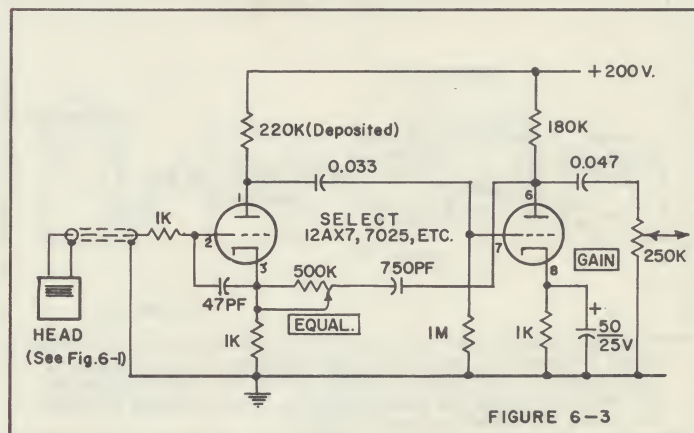


FIG 6-2 Typical NAB type amplifier response for 7.5 ips playback; dashes show limits obtained by variation of equalizer for head differences.

The capacitor value determined in the above manner is approximately 750 mmfd. The corresponding potentiometer value is 50 K; the dashed curves shown in Figure 6-2 result when the resistance is varied to compensate for head response characteristics.



Although the triode has a much greater grid plate capacitance than a pentode, the use of equalization by feedback serves to raise the impedance to a sufficiently high value that will permit the use of high inductance playback heads. The feedback also helps to make the amplifier gain less dependent upon tube conditions at higher frequencies.

HEAD RESONANCE

It should be noted here that the wiring capacitance between adjacent turns and layers, especially on a high inductance playback head, can become a liability in tape recorder playback performance. This occurs when the self-inductance of the head and its associated wiring capacitance are high enough in value to form a parallel resonance in or near the high audio frequency limits. A rule of thumb should be that this parallel resonance frequency be at least one or two octaves (factors of one or two) above the highest audio frequency to be played back.

In the case of a practical laminated quarter-track head of one henry nominal inductance, such as the Nortronics 1200**/PB2Q2K*, the resonant frequency is approximately 50kc.

In some cases equipment designers will make use of such a relatively low resonant point to cooperate with the shielded cable from the head to boost the higher audio frequencies (20kc, for example) on playback.

MEASURING RESPONSE AND INPUT IMPEDANCE

A method of measuring playback amplifier response is shown in Figure 6-4. Here the impedance of the head will be an integral part of the circuit as it would be in actual operation. To further illustrate the importance of this technique, assume that a 1 henry playback head is being used in an amplifier that has an input impedance of only 100,000 ohms. Under these conditions the inductive reactance of the playback head at 10 kc would be about 60,000 ohms; this would produce a serious drop at the grid of the amplifier tube at this frequency.

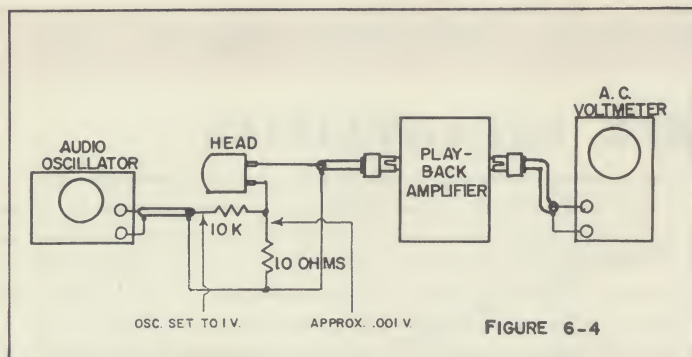


FIGURE 6-4 Method of measuring frequency response of playback pre-amplifier. The head is an integral part of the input circuit as it is in actual operation.

The output of the Nortronics 1200**/PB2Q2K* playback head is approximately 3 millivolts at 1 kc at 7.5 ips at reference recording level. (Reference recording level is approximately 12 db. below saturated tape). The 1000**/B2Q2K* combination head has an output of approximately 2.5 millivolts under the conditions stated above. When running the response of the amplifier the voltage across the 100 ohm resistor with either head should be restricted to about 1 millivolt (0.001 volts) to prevent amplifier overload at lower frequencies. This will be obvious upon examining curve 6-2 which shows that the response is up approximately 20 db. at 50 cycles referred to 1 kc. A properly designed amplifier should readily handle a 1 kc signal 15 to 20 db. above reference level with less than 5% total harmonic distortion; this will insure that amplifier distortion will not contribute to the overall tape recorder distortion at any normal operating level.

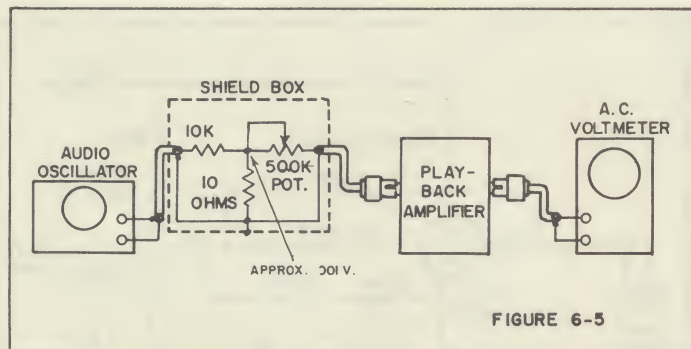


FIGURE 6-5 Method of measuring input impedance of an amplifier. A signal input of 0.001 volt is impressed and the output voltage of the amplifier noted; the potentiometer is then increased in resistance until the output voltage is halved.

Figure 6-5 shows a method of measuring input impedance. A well shielded 500 k potentiometer is inserted in series with the signal source and the amplifier. The potentiometer is first adjusted to a position of 0 resistance. A 1 kc signal of 1 millivolt is then inserted into the amplifier and the output reading is noted; the potentiometer is then adjusted until the output of the amplifier falls 6 db (one-half of its original voltage). The value of this potentiometer setting measured with an ohmmeter is the absolute value of the input impedance of the amplifier.

To obtain a complete input impedance picture, the above procedure should be duplicated at points over the entire frequency band from 20 to 20,000 cycles per second.

FILAMENT SUPPLY

The filaments of at least the first stage in a tape recording preamplifier should be energized by dc. This will greatly reduce hum pickup and correspondingly improve signal-to-noise readings. If design considerations necessitate the use of ac filament power, it would be well to use a circuit

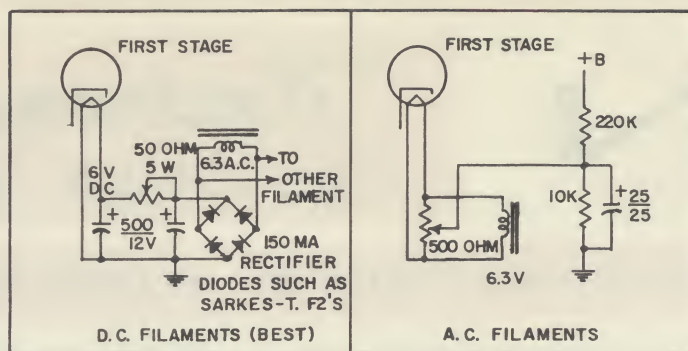


FIGURE 6-6 Methods of supplying filament power to input stage.

similar to that shown in Figure 6-6. The positive dc biasing and the corresponding hum adjust pot will provide good performance under most conditions.

PLATE POWER SUPPLY AND GROUNDING

The plate supply for a tape playback preamplifier should be well filtered and well regulated. The wiring should be carefully laid out so that ground loops will not be present in the circuit. A simplified layout schematic to accomplish this is shown in Figure 6-7. Care should be taken to avoid the use of more than one system chassis ground.

It should be pointed out here that the capacitive-resistive grid filters consisting of 47 mmf. capacitors and 1 k resistors will effectively eliminate any T.V. or F.M. rf detection at the grid of the tubes and thereby eliminate much annoying interference during tape playback.

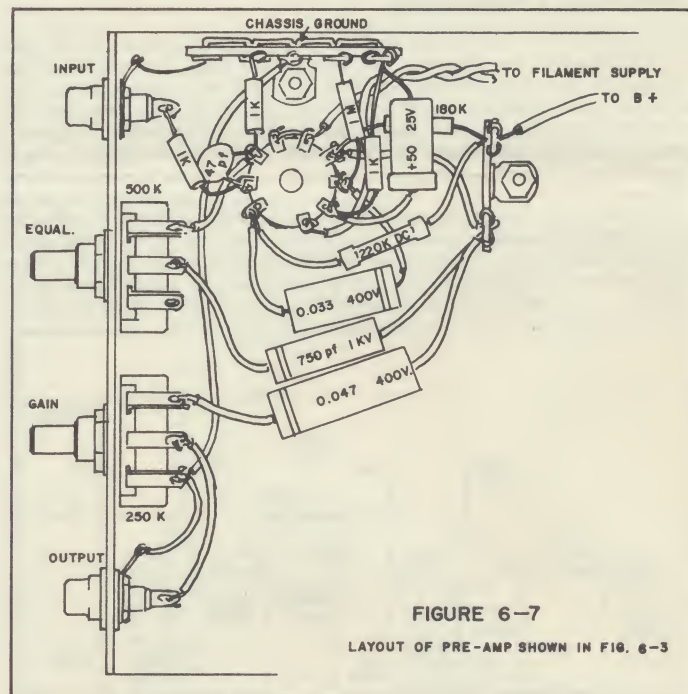


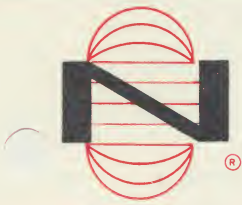
FIGURE 6-7

LAYOUT OF PRE-AMP SHOWN IN FIG. 6-3

Note to readers:

The circuits shown and described in this addendum are not necessarily free from patent design. The Nortronics Company assumes no responsibility for use in equipment design. These circuits have been tested and will provide good results in operation; this does not mean, however, that better tubes and other modifications would not provide better results under special conditions.

* Nortronics OEM Head Numbers.
** Nortronics Distributor Head Numbers



Nortronics®

CUSTOMER ENGINEERING BULLETIN

THE NORTRONICS COMPANY, INC. 8101 TENTH AVENUE NORTH MINNEAPOLIS, MINNESOTA 55427

TRANSISTORIZED PLAYBACK PREAMPLIFIER

GENERAL INFORMATION

Although the vacuum tube is widely used in tape recording amplification, the transistor is becoming more important in new equipment design. In inexpensive home machines current transistor prices now permit recorder manufacturers to compete with tubes especially when filament supplies, tube sockets, etc. are eliminated.

The following bulletin will discuss the design of an NAB type equalized, transistorized preamplifier for playback use at 7.5 ips. The following points will form the basis for the design:

- (1). The preamplifier must not be adversely affected by high ambient temperatures; in other words, noise characteristics must not change materially when the surrounding temperature is less than 180°F.
- (2). The signal-to-noise ratio must be as high as possible. This will be discussed for application with Nortronics low impedance heads.
- (3). Equalization should permit flat system response with a tape pre-recorded to NAB or similar standards.
- (4). Feedback equalization should be used to raise input impedance and reduce gain variations due to transistor differences. This is especially important if more than one preamp is constructed.
- (5). This unit must be capable of handling input levels with low distortion at least 15 db above reference recording level.
- (6). Any of the above points should be compromised only if it is necessary to make the amplifier less expensive.

DESIGN CHARACTERISTICS

The circuit is stabilized to prevent variations of performance with high operating temperature. This is accomplished by several techniques including d.c. negative feedback from the emitter of the second stage to the base of the first stage; direct coupling from the first stage collector to the second stage base is an integral part of the stabilization technique. Both stages are further stabilized by having relatively large bypassed emitter resistors.

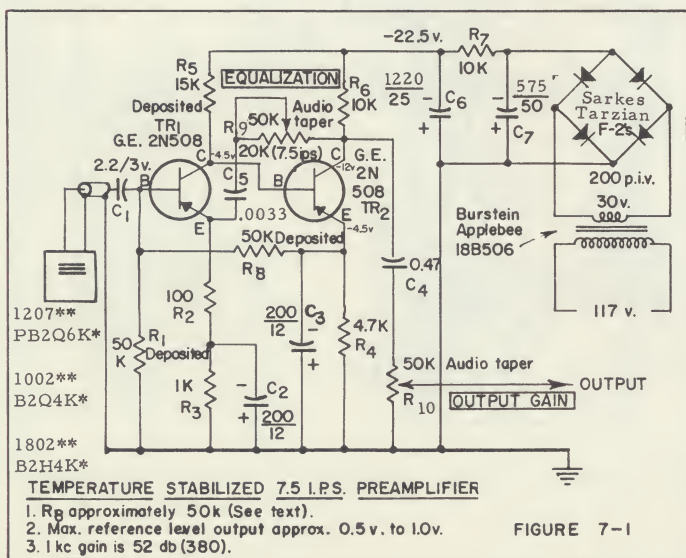
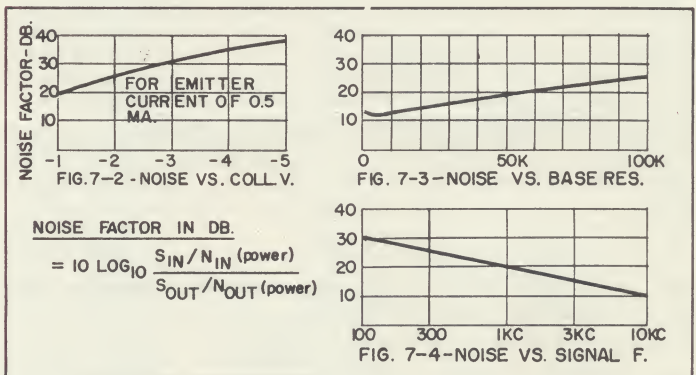


FIGURE 7-1

Obtaining a good signal-to-noise ratio involves a number of considerations which will be discussed very briefly. First it must be remembered that three factors contribute heavily to noise performance. These include the operating point (current and voltage) of the base and collector, the base resistance and the signal frequencies involved.

The operating point (see Figure 7-2) should be chosen to use low collector voltage. Here a compromise has been made; the collector voltage on the first stage is -4.5 volts which is necessary because the supply voltage of -22.5 volts establishes the collector voltage on the second stage (-12 volts) which in turn requires between -4 and -4.5 volts for proper bias on the base. This relatively high supply and collector voltage is necessary to retain large signal handling capacity with a head (such as the half track 1801**/B2H7K*) that has a reference level of .0012 volts and above at 1 kc at 7.5 ips. For heads having a nominal output below .0012 volts at reference level it might be desirable to reduce the supply voltage to as low as -12 volts. This will sharply reduce noise output without sacrificing amplifier gain and still give 15 db overload factor.



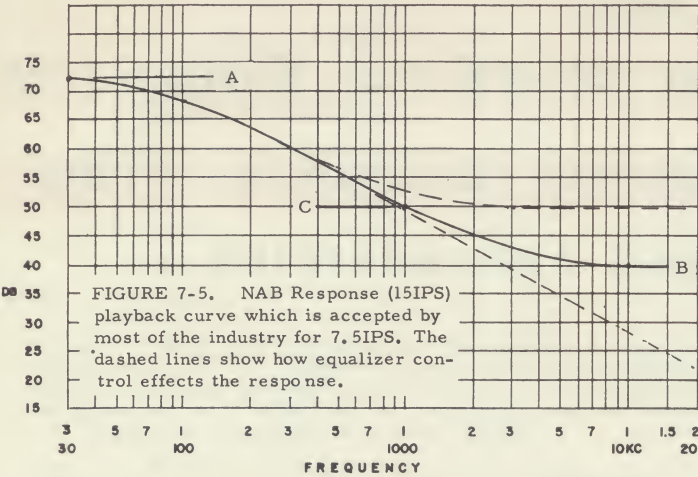
The base resistance is the parallel combination of the biasing resistors, and is approximately 20 to 25k. Referring to Figure 7-3 it will be seen that this again is a compromise from the optimum position. This is because the base resistance must be kept high enough to avoid degeneration of frequencies in the high audio frequency band. This will be discussed in detail later.

Unfortunately the noise factor rises with decreasing frequencies as shown in Figure 7-4. This shows that with frequencies below 10 kc the associated noise goes up approximately 10 db per decade decrease in frequency. This, of course, is an unavoidable problem and would be common to any transistor amplifier used in the audio band.

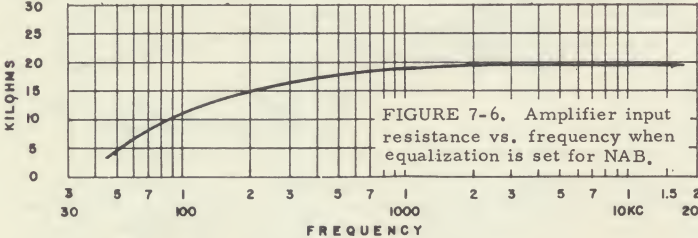
Determining the proper equalization to obtain the NAB type response curve as shown in Figure 7-5 will require some knowledge of head operation with a transistor amplifier. The transistor requires a discrete amount of input power; the magnetic head must actually furnish active power (current and voltage) during the playback process. This contrasts with the conventional vacuum tube preamplifier that usually has an input impedance well above 250k and requires only a voltage signal. The design tendency in professional vacuum tube preamplifiers, therefore, is to use a very high inductance playback head to enhance signal-to-noise ratio. Under these conditions the output of the head is limited only when the number of turns of the playback head and the corresponding self-inductance become so great that the self-parallel resonant frequency becomes low enough to adversely affect high audio frequency performance (see CEB #6).

In the transistor preamplifier the head impedance--which consists of the effective resistance of the head as well as the inductive reactance component--should be low enough over the entire audio band to provide negligible attenuation of high frequencies and yet high enough to take

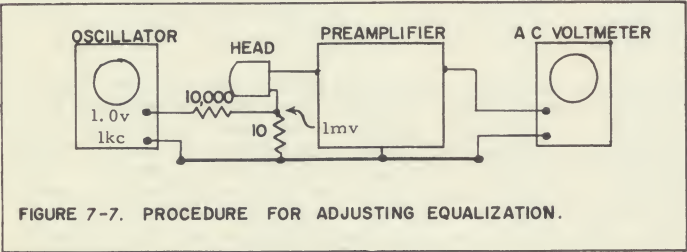
advantage of good power transfer to the transistor base. Practically speaking heads such as the Nortronics 1002**/B2Q4K*, 1207**/PB2Q6K* or 1802**/B2H4K* which have inductance of less than 200 millihenries will provide optimum performance for the amplifier shown in Fig. 7-1. A curve of amplifier input Z vs. frequency is shown in Fig. 7-6.



A simple method of determining the base resistor R_B and the feedback network will now be discussed: Omit the feedback network consisting of R_9 and C_5 and energize the circuit as shown in Figure 7-7. The head is included in the circuit to compensate for losses in power transfer from the head to the amplifier; the 0.001 volt signal across the 10 ohm resistor simulates the voltage generated by the head under actual playback. With this 1 kc signal fed into the amplifier as described, resistor R_B is adjusted until a maximum output is obtained on the collector of the second stage as observed by a high impedance a.c. voltmeter or oscilloscope. Under these conditions the output will be about 4.5 volts or a voltage gain of approximately 72 db. Next a temporary feedback network consisting of a large capacitor (about 0.1 mfd.) and a 100k potentiometer is inserted between the second stage collector and the first stage emitter (temporary R_9 and C_5). The potentiometer is then gradually decreased in resistance until the 1 kc output decreases to a point 32db below the maximum output point (about 1/40) in voltage ratio. These points are represented by A and B respectively in Figure 7-5. Retaining the potentiometer setting, the 0.1 mfd. capacitor is now experimentally reduced until the 1 kc response rises to 22 db (approximately 1/13) below the open loop gain. This is represented by C in Figure 7-5. The center value of the network C_5 and R_9 as determined in this manner is 0.0033 mfd. and 20k. A 50k potentiometer is



shown in the schematic; this can be adjusted above or below to achieve equalization differences to compensate for different tape speeds and small head differences. A further check on overall adjustments can be achieved under conditions of actual operation by using a commercial alignment tape such as the Nortronics AT-100.



As previously discussed the amplifier must be capable of handling input signals 15 db in voltage ratio above reference level. The Nortronics reference level is -12 db below tape saturation at 1 kc. This is not necessarily an accepted figure in the industry, but it is very close to a 2% total harmonic distortion point which is in turn centered within the industry.

* Nortronics OEM Head Numbers.
** Nortronics Distributor Head Numbers.

CONSTRUCTION HINTS

The amplifier just described will provide good performance at either 7.5 or 15 ips tape speeds. The only industry standard is the NAB type 15 ips curve as shown in Figure 7-5; fortunately the industry has generally accepted this same general curve for most 7.5 ips work. At 3.75 and 1.875 ips the potentiometer must be increased to provide the desired system response; appropriate information for doing this is discussed in CEB #2.

General amplifier performance is summarized in Figure 7-8.

HEAD TYPE	INDUCT MH.	1KC REF. LEVEL HEAD OUT.	AMPLIFIER DC SUPPLY VOLTAGE	AMPLIFIER NOISE OUTPUT	1KC REF. LEVEL AMPL. OUT.	AMPLIFIER GAIN 1 KC	REF. LEVEL SIGNAL TO NOISE RATIO
B2Q4K* 1002** Quarter	100	0.75mv	-12v	1.4mv	0.3v	52db	47db
PB2Q6K* 1207** Quarter	200	1.1	-12	1.4	0.45	52	50
B2H4K* 1802** Half	100	1.0	-12	1.4	0.42	52	49
B2H7K* 1801** Half	350	2.0	-22.5	2.5	0.83	53	51
SLF41* Full	100	2.5	-22.5	2.5	1.00	53	52

① THIS HEAD HAS A HIGH ENOUGH INDUCTANCE TO DEPRECIATE HIGH FREQUENCY AUDIO PERFORMANCE WITH THIS AMPLIFIER.

FIGURE 7-8. SUMMARY TABLE OF AMPLIFIER PERFORMANCE.

AMPLIFIER PARTS LIST

R_1, R_8 - 50,000 ohms, deposited carbon, 1/8 to 1/2 watt, 5%
 R_2 - 100 ohms, 1/2 watt, 10%
 R_3 - 1,000 ohms, 1/2 watt, 10%
 R_4 - 4,700 ohms, 1/2 watt, 10%
 R_5 - 15,000 ohms, deposited carbon, 1/8 to 1/2 watt, 5%
 R_6, R_7 - 10,000 ohms, 1/2 watt, 10%
 R_9, R_{10} - 50,000 ohm potentiometer audio taper (typical CTS-IRC-13-123-PQ)
 C_1 - 2.2 mfd., 3 volts (Sprague Hy-150)
 C_2, C_3 - 200 mfd., 12 volts, electrolytic (Sprague 1137)
 C_4 - 0.47 mfd., 200 volts, (Sprague type 155P)
 C_5 - 0.0033 mfd., 600 volts (Sprague 6TM-D33)
 C_6 - 1.220 mfd., 25 volts, electrolytic (MEC type B)
 C_7 - 575 mfd., 50 volts, electrolytic (MEC type B)
Power Transformer - 117: 50 volts
(Burrstein - Applebee 18B506)
4 Silicon Rectifiers - 200 P.I.V. (Sarkes-Tarzan F2)
TR1, TR2 - Transistor 2N508 (General Electric)
Chassis - (Bud Minibox CU-2113-A)
2 Tip Jacks - (Switchcraft 3501FP)

Note to readers: The circuits shown are not necessarily free from patent design. Nortronics assumes no responsibility for use in commercial equipment.



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CUSTOMER ENGINEERING BULLETIN

THE NORTRONICS COMPANY, INC. 8101 TENTH AVENUE NORTH MINNEAPOLIS, MINNESOTA 55427

TRANSISTORIZED RECORDING AMPLIFIER

GENERAL INFORMATION

The design of a magnetic recording amplifier will be discussed in the following bulletin. Since the transistor is becoming increasingly important in new equipment design it is felt that it should be treated separately from the vacuum tube.

A transistor requires no filament or heater elements and is ready to function as soon as the operating voltage is applied to the collector. As a result, objectionable line hum can generally be eliminated or reduced to very low levels. Operating voltage supplies of transistors usually run between 5 and 40 volts DC; this means that the transistorized recording amplifier can usually be designed to provide sufficient audio voltage drive without transformers to properly feed record heads with inductance readings as high as 300 millihenries.

A simplified discussion on transistor noise has been given in CEB #7. It was pointed out that three factors contributed heavily to improve noise performance. They included selection of a low voltage and current operating point, selection of low base resistance, and selection of signal frequencies to be amplified. Since the frequencies involved are necessarily in the audible range, the designer cannot make use of the fact that higher frequencies can be amplified with less associated noise.

The amplifier will primarily be for 7.5 ips tape speed with the following design points in mind:

1. The amplifier must not be adversely affected by high ambient temperatures; noise and gain characteristics must not change materially when the surrounding temperature is less than 170°F.
2. The signal-to-noise ratio must be as high as possible.
3. Equalization should produce flat final system response with Nortronics low impedance recording heads when the playback preamplifier is adjusted to the NAB type standard.
4. The input microphone impedance must permit use of a medium high impedance magnetic microphone.
5. The unit must be capable of providing audio current at least 15 db above reference recording level at 1 kc.
6. The bias oscillator must be capable of providing a bias frequency of at least 70 kc or more with low distortion.
7. Any of the above points should be changed only when amplifier expense tends to become prohibitive, or if adjustment and alignment techniques become overly complicated.

The recording amplifier must perform several functions to properly impress a magnetic recording on tape. The microphone or high level signal must be amplified, pre-equalized, and presented as a recording current signal to the head. At the same time an oscillator operating in the low supersonic range (in this case between 70 and 80 kc) provides a bias current which is electrically added—not modulated—to the audio current supplied to the head. Figure 8-1 illustrates a block schematic of the amplifier that will be described in this bulletin. This same oscillator supplies energy to erase the tape.

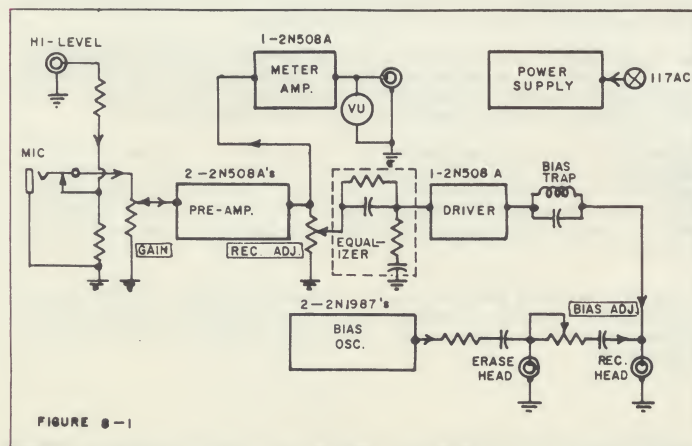


FIGURE 8-1

DESIGN CHARACTERISTICS

The operating point of the input stage is chosen so that the collector voltage is under 5 volts. This will provide a good signal-to-noise ratio under most operating conditions. The external base resistance is approximately 50,000 ohms; the parallel combination of the two biasing resistors. This provides somewhat of a compromise between the best noise performance and sufficiently high input impedance for hi-Z microphone use. The actual input impedance is, of course, a function of the feedback network.

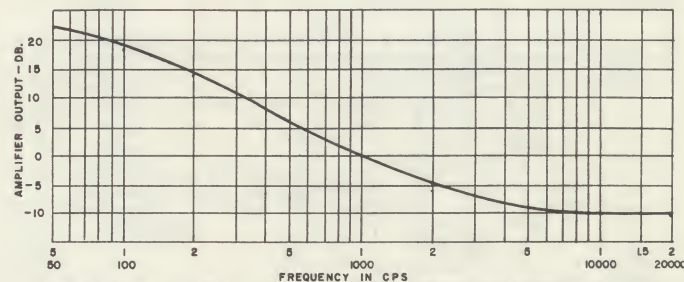


FIGURE 8-2 PLAYBACK AMPLIFIER RESPONSE WITH CONSTANT VOLTAGE INPUT INCLUDING HEAD IMPEDANCE.

The equalization for 7.5 ips is arrived at by simply extrapolating back to the NAB playback curve, the basic Nortronics constant current head response curve, and the assumption that flat system response from 50 to 20 kc is desired. The NAB playback curve is shown in Figure 8-2; this playback curve, although unofficial for 7.5 ips, is generally used by manufacturers of quality tape recorders. It represents what the output voltage of the amplifier will look like when the input is energized with a constant voltage signal in series with the playback head impedance over the audible range. CEB #6 and CEB #7 describe methods of checking playback amplifier response.

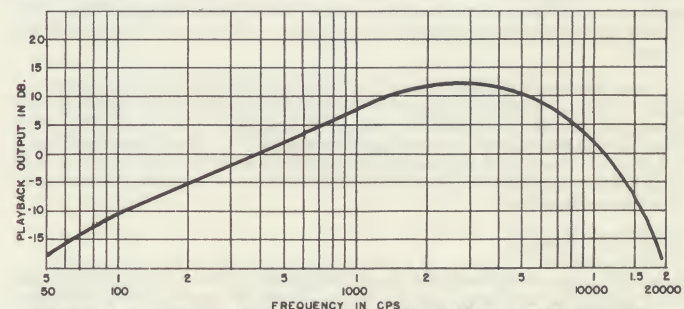


FIGURE 8-3 TYPICAL PLAYBACK HEAD RESPONSE FROM A TAPE RECORDED WITH CONSTANT CURRENT AT PEAK BIAS AT 7.5 IPS.

The curve shown in Figure 8-3 is a detailed average plot of the constant current characteristic of a typical Nortronics head such as the Model 1000 (B2Q2K). This curve would result when taking the unequaled, open circuit voltage from the terminals of a playback head that had previously been used to record the signal under conditions of constant recording current and bias current adjusted to peak 1 kc response.

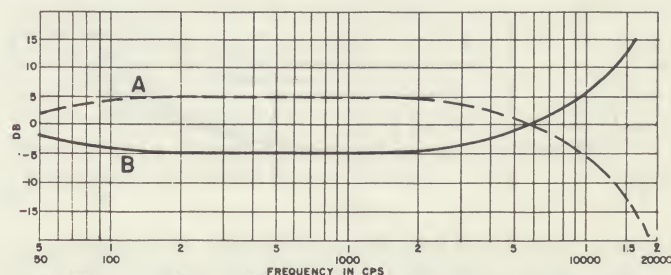
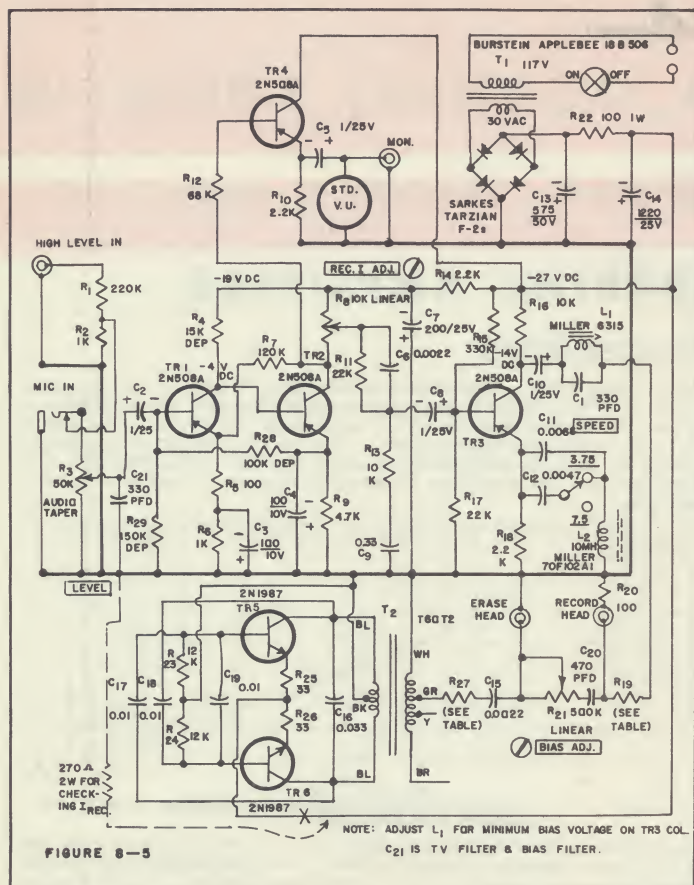


FIGURE 8-4 CURVE A RESULTS WHEN CURVE 8-3 IS SUBTRACTED FROM CURVE 8-2. B IS THE INVERSE AND REPRESENTS WHAT THE RECORD HEAD CURRENT SHOULD BE FOR FLAT SYSTEM RESPONSE.

Figure 8-2 the resultant curve is shown in Figure 8-4; it is the inverse of the curve required during the recording process to give flat, overall system response. The inverted curve which represents the desired head audio current for the amplifier designed is also shown in Figure 8-4.

The amplifier schematic is shown in Figure 8-5. The first two stages of the amplifier have a small amount of linear negative feedback included to stabilize gain, increase input impedance and generally provide amplification with low distortion between the microphone and high level inputs and the equalizer, driver stage to the head.



For purposes of convenience the bias oscillator generally provides the energy for the erase head during the recording process. The push-pull oscillator shown in Figure 8-5 provides low distortion energy at approximately 80 kc. R-27 and C-15 provide an erase coupling network which will properly feed a 1401** (SEQ4*), 2201** (SEH4*), or 4401** (MEF4*) Nortronics erase head. R-21 and C-20 provide a network to properly inject bias current into the record head. A bias trap consisting of L-1 and C-19 provide a buffer impedance which eases the oscillator requirement and also reduces bias intermodulation at the collector of the driver stage.

- R1 - 220k 1/2 w 10%
- R2, R6 - 1k 1/2 w 10%
- R3 - 50k pot audio taper
- R4 - 15k dep. carbon 1/8-1/2 w 5%
- R5, R20 - 100 ohm 1/2 w 10%
- R7 - 120k 1/2 w 10%
- R8 - 10k pot linear
- R9 - 4.7k 1/2 w 10%
- R10, R14, R18, - 2.2k 1/2 w 10%
- R11, R17 - 22k 1/2 w 10%
- R12 - 68k 1/2 w 10%
- R13, R16 - 10k 1/2 w 10%
- R15 - 330k 1/2 w 10%
- R19 - (see table)
- R21 - 500k pot linear
- R22 - 100 1 w 10%
- R23, R24 - 12k 1/2 w 5%
- R25, R26 - 33 ohm 1/2 w 10%
- R27 - (see table)
- R28 - 100k dep. carbon 1/8-1/2 w 5%
- R29 - 150k dep. carbon 1/8-1/2 w 5%

- C11 - .0068 mfd./100 v paper
- C12 - .0047 mfd./100 v paper
- C13 - 575 mfd./50 v
- C14 - 1200 mfd./25 v
- C16 - .033 mfd./100 v paper
- C17, C18, C19 - .01 mfd./100 v paper
- C20 - 470 pfd./500 v ceramic
- C21 - 330 pfd./500 v ceramic

L1 - adjustable choke 4/30 mh.

Miller 6315

L2 - fixed choke 10 mh.

Miller 70F102A1

T1 - Power transformer - B. A. 18B506

4 Silicon Rectifiers - Sarnes Tarzian F-2

T2 - bias oscillator

T60T2

4 tip jacks - Switchcraft 3501FP

TR5, TR6 - 2N1987 silicon transistors

(Minneapolis-Honeywell)

Microphone Connector - single close

circuit (Switchcraft 12A)

Equalization Switch, Power Switch, Etc.

standard VU meter

TRI, TR2, TR3, TR4 - 2N508A

germanium transistors

(General Electric)

- C1 - 330 pfd./500 v ceramic
- C2, C5, C8, C10 - 1 mfd./25 v elect.
- C3, C4 - 100 mfd./10 v elect.
- C6, C15 - .0022 mfd./100 v paper
- C7 - 200 mfd./25 v elect.
- C9 - .33 mfd./25 v ceramic

MODE	RECORD HEAD	ERASE HEAD	T2 TAP	R ₂₇	R ₁₉	I _{BIAS}	I _{REC} (KC)
HI Z-QUARTER R/P	1200** PB2Q2K*	1400** SEQ1*	BROWN	1000Ω	22kΩ	0.30 MA	0.02 MA
LO Z-QUARTER RECORD ONLY	1203** PB2Q4R*	1401** SEQ4*	GREEN	270Ω	0	0.70 MA	0.05 MA
LO Z-HALF R/P	2002** PB2H4K*	2201** SEH4*	GREEN	270Ω	0	0.80 MA	0.07 MA
LO Z-HALF RECORD ONLY	2003** PB2H4R*	2201** SEH4*	GREEN	270Ω	0	0.70 MA	0.07 MA
LO Z-FULL RECORD ONLY	4101** SLFH4R*	4401** MEF4*	GREEN	0	0	1.2 MA	0.100 MA

FIG. 8-7 DATA FOR SEVERAL NORTRONICS HEADS. Measure bias current across R20 with a good electronic AC meter such as a Ballantine 310A. Measure record current by replacing the oscillator with a 270 ohm 2 watt load (see Figure 8-5).

CONSTRUCTION AND ALIGNMENT

Construction of the amplifier should follow good standard practice and excessive heat should be avoided when soldering transistors and components. The power transformer should be located away from the input transistor and if possible it should be shielded with an external steel case.

The use of the gain control before the first stage is rather unusual; it will not be a source of noise if a good quality control is used. There are several good reasons for placing the control in this position; they include: (1) The amplifier cannot be over-loaded under any conditions. (2) Feedback can be applied between the first and second stage which will help to make the gain independent of transistor beta variations. The philosophy of design in this amplifier tends to promote operation at the highest signal-to-noise ratios under all conditions. The standard VU-meter which is driven by the emitter follower is, in turn, directly connected to the output of the first two stages. Therefore, when a recording is being made sufficiently high in level to give proper reading on the VU-meter (peaks from 0 to +2) the operator is making full and proper use of signal level in the first two stages.

The amplifier can be used with almost any of the currently available Nortronics record and combination record/playback heads. The table shown in Figure 8-7 gives the necessary data to adapt the amplifier for several types of heads. Using the amplifier with heads other than listed may result in depreciated performance.

Approximate bias current and reference level recording current can be pre-set from data given in Figure 8-7. Accurate determination of bias and record currents can best be achieved by using a deck with an independent playback head and amplifier. Under these conditions the bias current is adjusted until the 1 kc response is maximum and the record current is adjusted until "0-VU" on the meter is one-fourth (-12 db) of saturation level.

It must be remembered that full frequency response at 7.5 ips must be checked at least 15 db below reference recording level; this is discussed thoroughly in CEB #2. 3.75 equalization is obtained by simply switching the additional capacitor (C12) into the circuit.

The equalizing components in the amplifier include R-11, C-6, R-13, C-9, C-11, C-12 and L-2. With frequencies between 200 and 1,500 cps R-11 and R-13 act as a straight voltage divider between the output of the record current adjust and the base input of the last stage. At frequencies below 200 cps the impedance (capacitive reactance) of C-9 becomes increasingly higher as the frequency goes down. This produces the slightly rising characteristic which is called for in Figure 8-4 at the low end.

At frequencies above 1,500 cps, capacitor C-6 begins to shunt resistor R-11 producing an increasing amplitude of signal at the base of the driver transistor as the frequency goes up. The series resonant action of C-11 and L-2 provides a further assist to the high end boost up to a peak of approximately 20 kc. This LC peaking circuit offers a further advantage of suppressing noise above 20 kc. The resulting curve from the high boost is shown in Figure 8-6; note that this curve is nearly the same as is called for in Figure 8-4.

THE BIAS OSCILLATOR

As previously mentioned it is necessary to add a supersonic "bias current" to the audio current during the recording process; the amplitude (or magnitude) of this current is approximately ten times the amplitude of the average audio current. If it is too high it will result in unwanted degeneration of the higher audio frequencies, and if it is too low, recording stability, distortion, and dynamic range will all be adversely affected. At the so called "peak bias" operating mode, the 1 kc signal recorded on the tape will be at its maximum value; this is a good practical point to operate a recording system. It should be noted that the curve in Figure 8-3 is a peak bias curve.

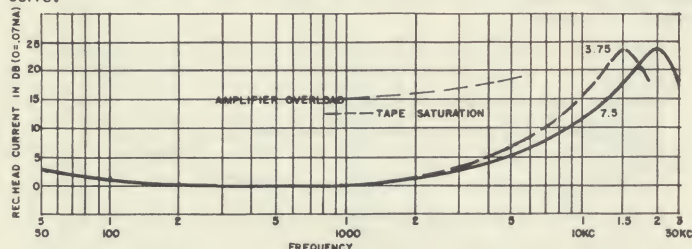


FIGURE 8-6 RECORD AMPLIFIER RESPONSE WITH HEAD 2003** (PB2H4R*). 0 db is 0 VU at 1 KC with a head current of 0.070 MA (70 Micro-amps). Note that the amplifier overload point is above the tape saturation at 1KC. With a quality playback head such as a NORTRONICS 2002** (PB2H4K*) and the playback preamplifier described in CEB 7, flat system response between 50 and 15,000 cps is easily attained at 7.5 ips.

* Nortronics OEM Head Numbers.

** Nortronics Distributor Head Numbers.

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CUSTOMER ENGINEERING BULLETIN

THE NORTRONICS COMPANY, INC. 8101 TENTH AVENUE NORTH MINNEAPOLIS, MINNESOTA 55427

TRANSISTORIZED RECORDING AMPLIFIER

GENERAL INFORMATION

The design of a magnetic recording amplifier using silicon transistors will be discussed in the following bulletin.

A transistor requires no filament or heater element and is ready to function as soon as the operating voltage is applied to the collector. Objectionable 60 cycle hum can generally be eliminated or reduced to very low levels. Operating voltage supplies for transistor amplifiers usually run between 5 and 40 volts DC; thus the transistorized recording amplifier can easily be designed to provide sufficient audio voltage to drive heads with inductance readings as high as 300 mhy. CEB #7 contains a simplified discussion on transistor noise. It was pointed out there that three factors contribute to the amplifier noise performance. The first stage should have a low voltage and current operating point. The base resistance should be low and the signal frequencies to be amplified are a factor. Since the frequencies involved are necessarily in the audible range, the designer must compromise with the fact that higher frequencies can be amplified with less associated noise. The amplifier described will be designed for use at 7.5, 3.75 and 1.875 ips. The design will keep the following points in mind:

1. The amplifier will not change gain characteristics when the surrounding temperature is under 190° F.
2. The signal-to-noise ratio will be as high as possible.
3. The equalization will produce flat system response with Nortronics low impedance recording heads when the playback amplifier is adjusted to NAB type standards.
4. The microphone input impedance will permit the use of a magnetic microphone of medium high impedance.
5. The unit must be capable of providing audio current at least 15 db above reference recording level at 1 kc.
6. The bias oscillator should be capable of providing a bias frequency of at least 70 kc or more with low distortion.
7. Component expense should not become prohibitive.

The recording amplifier must perform several functions to properly impress a magnetic recording on tape. The microphone or high level signal must be amplified, equalized, and presented as a recording current to the head. At the same time an oscillator operating at about 70 kc must provide a bias current which is electrically added to the audio current that is supplied to the head. Figure 9-1 illustrates a simplified schematic of the amplifier to be described. The 70 kc oscillator also supplies energy to erase the tape.

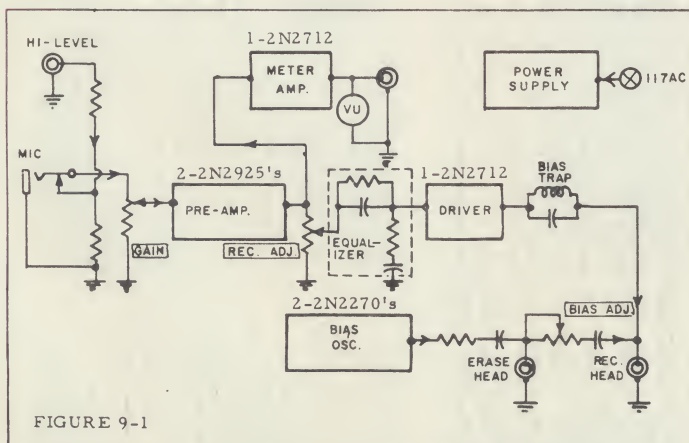


FIGURE 9-1

DESIGN CHARACTERISTICS

The operating point of the input stage is under three volts. This provides good signal-to-noise performance under most operating conditions. It is a compromise between optimum noise performance and the necessary condition of providing sufficiently high input impedance for a hi-Z magnetic microphone. The actual input impedance is, of course, a function of the feedback network used in the amplifier.

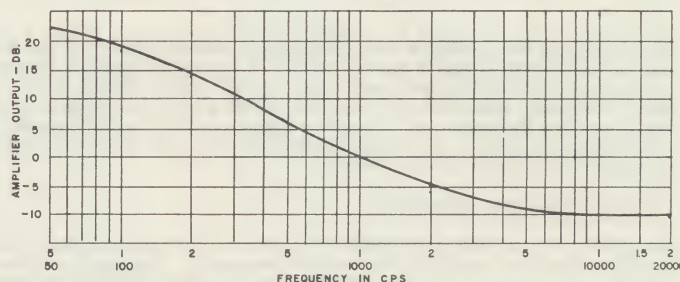


FIGURE 9-2 PLAYBACK AMPLIFIER RESPONSE WITH CONSTANT VOLTAGE INPUT INCLUDING HEAD IMPEDANCE.

The necessary equalization for 7.5 ips is arrived at by extrapolating back to the NAB playback curve, the Nortronics constant-current curve, and the assumption that flat system response is desired. To simplify the description, the curves are shown only for 7.5 ips operation. The NAB playback curve is shown in Figure 9-2; it is unofficial for 7.5 ips, but it is generally used by manufacturers of quality tape recorders. It represents what the output voltage of the amplifier will look like when the input is energized with a constant voltage signal in series with the playback head impedance over the audible range. The reader is advised to refer to CEB #6 and CEB #7 which describes methods of checking playback amplifier response.

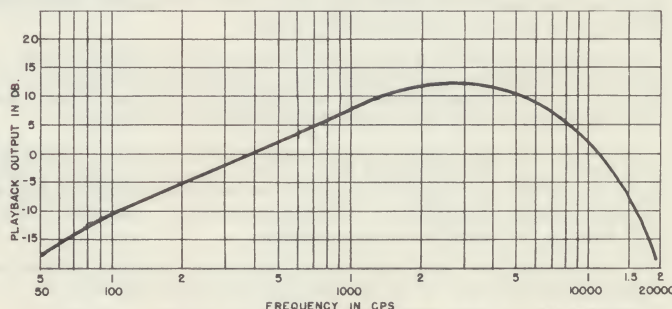


FIGURE 9-3 TYPICAL PLAYBACK HEAD RESPONSE FROM A TAPE RECORDED WITH CONSTANT CURRENT AT PEAK BIAS AT 7.5 IPS.

The curve shown in Figure 9-3 is a detailed average plot of the constant current characteristics of a typical Nortronics head such as the model 1000 (B2Q2K). This curve would result when taking the unequaled, open circuit voltage from the terminals of a head that had been previously used to record the signal under conditions of constant current recording and the bias current adjusted to a peak 1 kc response. When the curve in Figure 9-3 is subtracted from the curve shown in Figure 9-2, a resultant curve is shown in Figure 9-4; the inverse of this curve represents the desired audio head current to give overall flat system response.

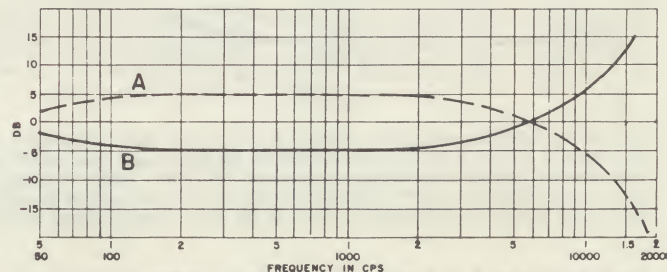


FIGURE 9-4 CURVE A RESULTS WHEN CURVE 9-3 IS SUBTRACTED FROM CURVE 9-2. B IS THE INVERSE AND REPRESENTS WHAT THE RECORD HEAD CURRENT SHOULD BE FOR FLAT SYSTEM RESPONSE.

The amplifier schematic is shown in Figure 9-5. The first two stages of the amplifier have a small amount of linear negative feedback to stabilize gain, increase input impedance and generally provide amplification with low distortion between the microphone or high level input and the equalizer driver stage to the head.

The equalizing components in the amplifier include R11, C6, R13, C9, L2 and C11. At frequencies between 200 and 1500 cps R11 and R13 act as a straight voltage divider between the output of the linear amplifier and the input to the driver stage. At frequencies below 200 cps the impedance (capacitive reactance) of C9 becomes increasingly higher as the frequency goes down. This produces the slightly rising characteristic that is called for in Figure 9-4 at the low end.

At frequencies above 1500 cps capacitor C6 begins to shunt resistor R11 producing an increasing amplitude of signal at the input of the driver transistor as the frequency goes up. The series resonant action of L2 and C11 provides a further assist to the high end boost up to a peak of approximately 20 kc. This LC peaking circuit tends to suppress noise above 20 kc. The resulting curve from the high boost is shown in Figure 9-6; note that this curve is nearly the same as is called for in Figure 9-4.

THE BIAS OSCILLATOR

As previously mentioned, it is necessary to add a supersonic "bias current" to the audio current during the recording process; the amplitude (or magnitude) of this current is approximately ten times the amplitude of the average audio current. If it is too high it will result in unwanted degeneration of the higher audio frequencies, and if it is too low, recording stability, distortion, and dynamic range will all be adversely affected. At the so called "peak bias" operating mode the 1 kc signal recorded on the tape will be at its maximum level; this is a good practical point to operate a recording system. It should be noted that the curve in Figure 9-3 is a peak bias curve.

For purposes of convenience the bias oscillator generally provides the energy for the erase head during the recording process. The push-pull oscillator shown in Figure 9-5 provides low distortion energy at approximately 80 kc. R-27 and C-15 provide an erase coupling network which will properly feed a 1401** (SEQ4*), 2201** (SEH4*), or 4401** (MEF4*) Nortronics erase head. R-21 and C-20 provide a network to properly inject bias current into the record head. A bias trap consisting of L-1 and C-19 provide a buffer impedance which eases the oscillator requirement and also reduces bias intermodulation at the collector of the driver stage.

CONSTRUCTION AND ALIGNMENT

Construction of the amplifier should follow good standard practice and excessive heat should be avoided when soldering transistors and components. The power transformer should be located away from the input transistor, and if possible it should be shielded with an external steel case.

The use of the gain control before the first stage is rather unusual; it will not be a source of noise if a good quality control is used. There are several good reasons for placing the control in this position; they include: (1) The amplifier cannot be overloaded under any condition. (2) Feedback can be applied between the first and second stage which will help to make the gain independent of transistor beta variations. The philosophy of design in this amplifier tends to promote operation at the highest signal-to-noise ratios under all conditions. The standard VU meter which is driven by the emitter follower is, in turn, directly connected to the output of the first two stages. Therefore, when a recording is being made sufficiently high in level to give proper reading on the VU meter (peaks from 0 to +2), the operator is making full and proper use of signal level in the first two stages.

The amplifier can be used with almost any of the currently available Nortronics record and combination record/playback heads. The table shown in Figure 9-7 gives the necessary data to adapt the amplifier for several types of heads. Using the amplifier with heads other than listed may result in depreciated performance.

Accurate bias current and reference level recording current can be pre-set from data given in Figure 9-7. A more accurate determination of bias current can be achieved by adjusting the bias until a given 1 kc record level (well below saturation) produces the highest reading during playback. 1 kc playback voltage is below this maximum point when the bias current is too low or too high.

The record current level can best be determined by making use of a test tape such as the new Nortronics AT-100 that has a pre-recorded tone at reference level.

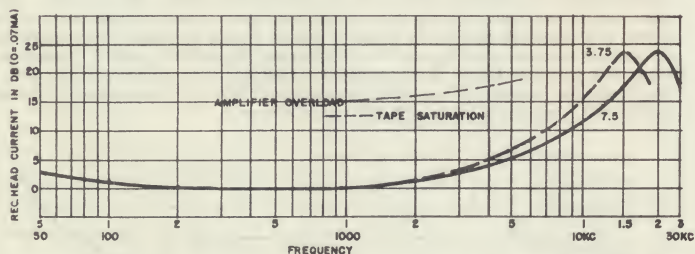


FIGURE 9-6 RECORD AMPLIFIER RESPONSE WITH HEAD 2003** (PB2H4R*). 0 db is 0 VU at 1 KC with a head current of 0.070 MA (70 Micro-amps). Note that the amplifier overload point is above the tape saturation at 1 KC. With a quality playback head such as a NORTONICS 2002** (PB2H4K*) and the playback preamplifier described in CEB 7, flat system response between 50 and 15,000 cps is easily attained at 7.5 ips.

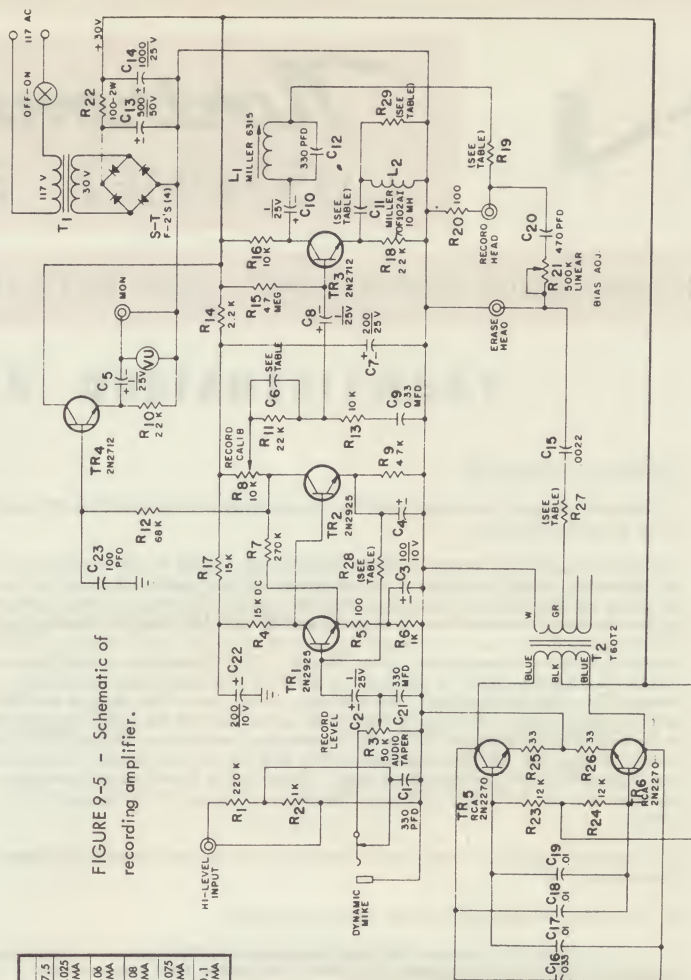


FIGURE 9-5 - Schematic of recording amplifier.

MODE	RECORD HEAD	ERASE HEAD	T2	R97	R19	C6	C11	R99	BIAS	I RECORD
W 2 - E/P	SEF01	SEF01	Green	1K	1K	1.875	3.75	7.5	1.875	3.75
Quadrant Track	1201	1400	Green	1K	1K	1.875	3.75	7.5	1.875	3.75
Lo 2 - Record	P-B2H4R	SEF04	Green	2700	2700	1.875	3.75	7.5	1.875	3.75
Quadrant Track	1203	1401	Green	2700	2700	1.875	3.75	7.5	1.875	3.75
Lo 2 - R/P	P-B2H4K	SEF04	Green	2700	2700	1.875	3.75	7.5	1.875	3.75
Half Track	2002	2201	Green	2700	2700	1.875	3.75	7.5	1.875	3.75
Lo 2 - Record	P-B2H4R	SEF04	Green	2700	2700	1.875	3.75	7.5	1.875	3.75
Half Track	2003	2201	Green	2700	2700	1.875	3.75	7.5	1.875	3.75
Lo 2 - Record	SUPHAR	MEF4	Green	2700	2700	1.875	3.75	7.5	1.875	3.75
Full Track	4101	4401	Green	2700	2700	1.875	3.75	7.5	1.875	3.75

- C1, C11, C12, C21 - 200 pfd, 500 v ceramic
C2, C3, C8, C10 - 1 mfd, 25 v elect.
C3, C4 - 100 mfd, 10 v elect.
C6 - see table
C7 - 200 pfd, 25 v elect.
C9 - 0.33 mfd, 25 v ceramic
C11 - see table
C13 - 500 mfd, 50 v elect.
C14 - 1000 mfd, 25 v elect.
C15 - .002 mfd, 200 v paper
C16 - .033 mfd, 100 v paper
C17, C18, C19 - .01 mfd, 100 v paper
C20 - 470 pfd, 500 v ceramic
C22 - 200 mfd, 10 v elect.
C23 - 100 pfd, 500 v ceramic
L1 - adjustable choke 420 mH, Miller 6315
L2 - fixed choke 10 mH, Miller 70F102A1
L3 - power transformer Bussan Appliance 18B506
Silicon Rectifiers - Sanken-Toshiba F-2
L2 - Nortronics oscillator coil 14012
- R1 - 220K 1/2 W 10%
R2, R6 - 1K 1/2 W 10%
R3 - 50K pot audio taper
R4 - 15K DC 1/8 W 5%
R5, R20 - 100 ohm 1/2 W 10%
R7 - 270K 1/2 W 10%
R8 - 10K pot linear taper
R9 - 4.7K 1/2 W 10%
R10, R14, R16 - 2.2K 1/2 W 10%
R11 - 22K 1/2 W 10%
R12 - 68K 1/2 W 10%
R13, R16 - 10K 1/2 W 10%
R17, R18 - 10K 1/2 W 10%
R19 - see table
R21 - 500K pot linear taper
R22 - 100 ohm 1/2 W 10%
R23, R24 - 12K 1/2 W 10%
R25, R26 - 33 ohm 1/2 W 10%
R27 - see table
R28 - see note below table
R29 - see table
R29 - see table

SPECIAL NOTES:

R28 should be adjusted so that so that voltage on collector of TR2 is equal to one-half of the voltage at junction of R17, R14 and R8

L1 should be adjusted so that 80 kc bias voltage on collector of R16 is a minimum.

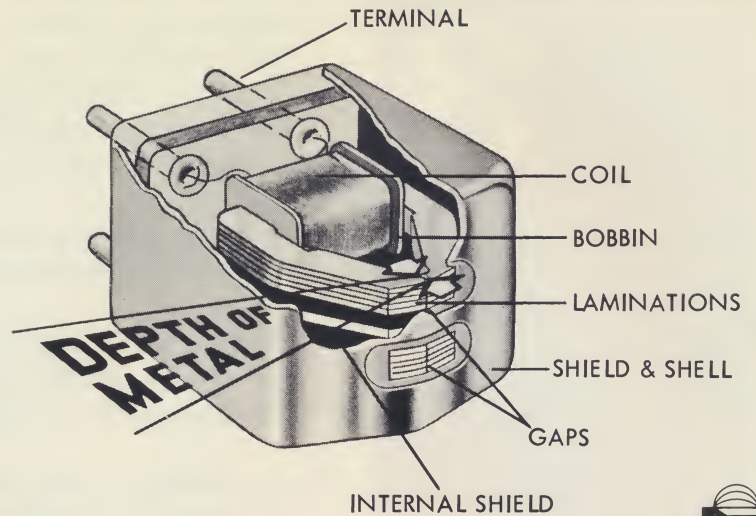
Be sure to use head sinks on TR5 and TR6.

TR1, TR2 - G.E. Transistor 2N2925
TR3, TR4 - G.E. Transistor 2N2712
TR5, TR6 - RCA Transistor 2N2270

1

WHAT'S INSIDE A TAPE HEAD?

These are the construction features of a typical Nortronics laminated tape head!

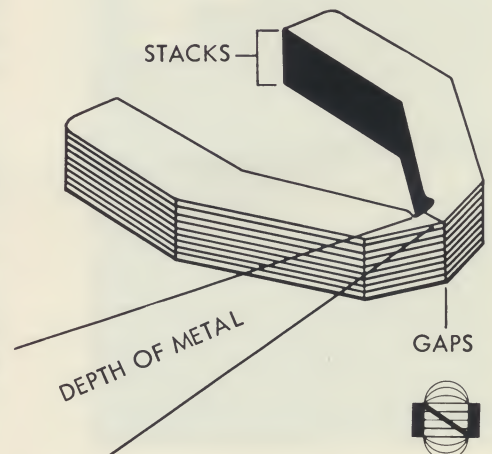


2

HOW DO ALL TAPE HEADS WEAR OUT?

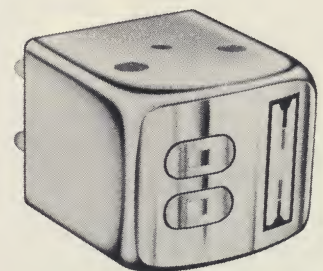
- Magnetic tape itself is the real cause of head wear! If you operate your tape recorder 5 hours a day at 7.5 IPS for only one month, 640 MILES OF TAPE HAS PASSED OVER THE HEAD FACE! That's why it is important to check heads regularly!
- The abrasive action of tape, as it passes over the face under pressure, grinds away the surface of the head.
- As wear progresses, the "Depth of Metal" is gradually worn away. The illustration shows the "Depth of Metal" found on a new head.

"DEPTH OF METAL" FOUND ON A NEW HEAD



NOW IS THE TIME TO GO "PROFESSIONAL" WITH NORTRONICS NEW "COMBO" HEAD...

- Have three heads on your tape recorder! With the "Combo" head, you can monitor your tapes while you record!
- The "Combo" head combines Record, Playback and Erase functions on one regular size Nortronics head.
- Your present playback head and a new Nortronics "Combo" head does the work of three heads in the space for two!



SEE YOUR AUTHORIZED NORTRONICS DEALER TODAY
FOR ALL REPLACEMENT HEADS AND ACCESSORIES!



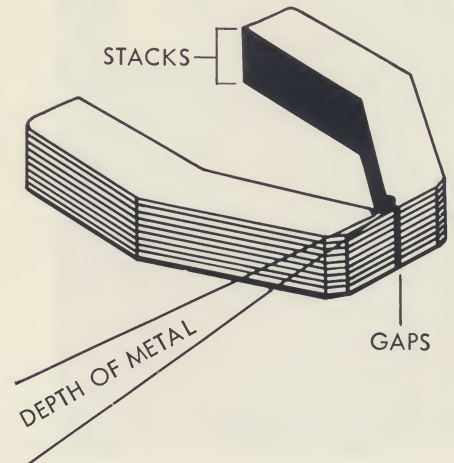
Nortronics[®]
Minneapolis, Minnesota 55427

3

WHAT HAPPENS
WHEN THE
"DEPTH OF METAL"
WEARS AWAY?

- Observe the "Depth of Metal" typically found on a worn head. The all important, intimate tape-to-gap contact becomes impossible because the surface of the head has worn unevenly.
- The tiny gap, between the stacks, wears through and eventually opens up.
- Finally, severe high frequency losses and erratic outputs occur, and the brilliant realism of tape is lost!
- The fidelity of the most expensive equipment is no better than the tape head reproducing it!

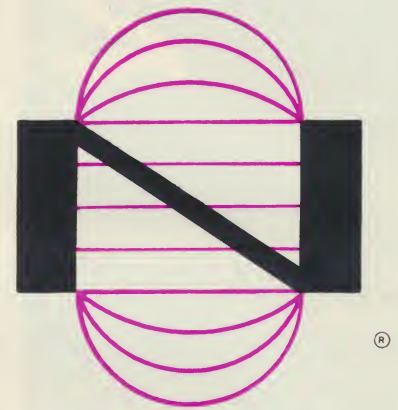
"DEPTH OF METAL" TYPICALLY
FOUND ON A WORN HEAD



4

WHAT'S THE
SOLUTION?

- REPLACE WORN HEADS WITH NEW NORTRONICS PREMIUM TAPE HEADS! Don't wait until serious sound reproduction losses occur!
- CHECK WITH YOUR NORTRONICS DEALER! Get full value from your growing investment in magnetic tape.
- YOUR NORTRONICS DEALER IS A SPECIALIST IN TAPE RECORDERS! He has the most complete tape head replacement program available anywhere!

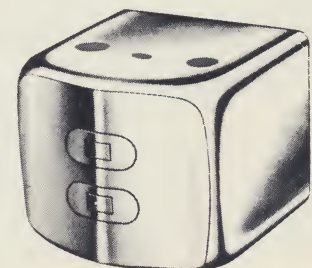


5

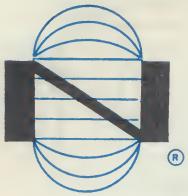
ONLY
NORTRONICS
OFFERS PREMIUM
BROADCAST QUALITY
REPLACEMENT
HEADS!

All Nortronic PREMIUM Heads Feature:

- 100 micro-inch gaps for better high frequency response!
- Precision lapping for straighter, truer gaps!
- Deposited quartz spacing for cleaner gaps; no smear!
- More laminations for increased efficiency!
- Smaller cores for less core losses!



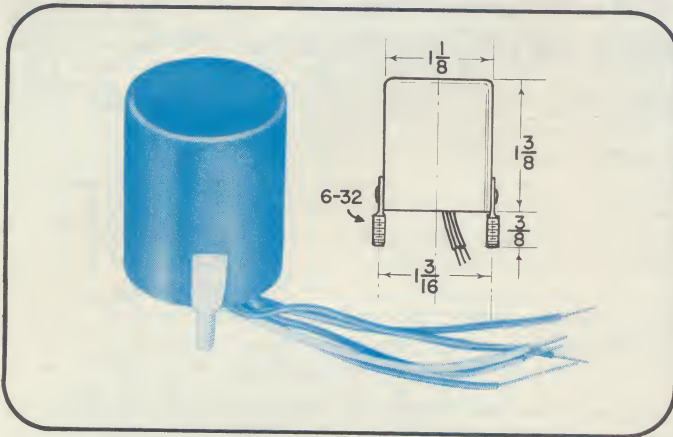
CHECK YOUR TAPE HEADS TODAY--THEN SEE YOUR NORTRONICS DEALER! HE HAS FACTORY RECOMMENDED REPLACEMENT HEADS FOR OVER 500 DIFFERENT TAPE RECORDERS!



Nortronics BIAS AND ERASE OSCILLATOR TRANSFORMERS

FOR TRANSISTOR AND VACUUM TUBE CIRCUIT USE

THE NORTRONICS COMPANY, INC. 8101 TENTH AVENUE NORTH MINNEAPOLIS, MINNESOTA 55427



T60 SERIES TRANSFORMERS

- FERRITE E-CORE CONSTRUCTION
- GOOD REGULATION
- HIGH EFFICIENCY, HIGH Q
- WIDE FREQUENCY RANGE
- WIDE VOLTAGE RANGE

Model T60-T2 is designed primarily for use with transistors. Models T60-E and T60-F are designed for medium frequency and high frequency vacuum tube use respectively. All T60 series transformers make use of ferrite E-core construction. The outstanding performance characteristics of the T60 units will insure low tape noise on erasure and low distortion during the recording process.

THE T60-T2 TRANSISTOR TRANSFORMER

TABLE 1

Lead Color Secondary Tap	Nominal Load Impedance	Max. Load Current Total	Voltage Under Load
Green	1.5K	35-45MA	30-40V
Yellow	6K	18-25MA	60-80V
Brown	13.5K	12-16MA	90-120V

Push-Pull Data
with Supply Volt
18-25VDC

PRI-L-0.13MH
PRI-DCR 0.40 OHMS

THE PUSH-PULL BIAS OSCILLATOR. The included schematic shows the T60-T2 used as a push-pull oscillator. This is a somewhat preferred method of operation; the greater power reserve, improved regulation, and reduced even-harmonic generation will provide a fully professional oscillator unit for the most critical applications. By making use of the data given in table 2 the designer can adapt the push-pull circuit for either high or low impedance heads at 60 kc and also low impedance heads at 60, 80, or 100 kc.

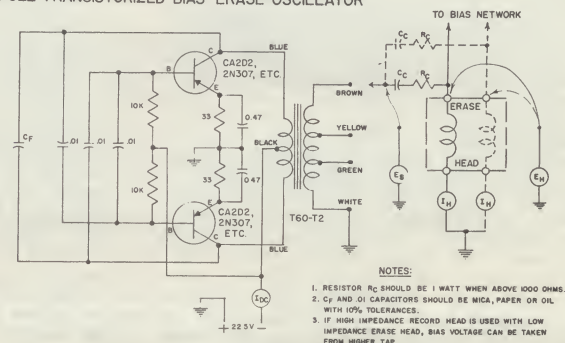
While the values shown in the table are only center-values, they will be within normal tolerances depending upon the components used, etc. For monaural use, the designer simply uses one section of the output as shown. The MEF4 being a full track head is, of course, a monaural head.

TRANSISTORS. Inexpensive transistors such as the Honeywell CA2D2, the Sylvania 2N307, etc., will provide performance well within transistor ratings when the supply voltage is between 18 and 25 volts. When it is desirable to make use of better temperature stabilization characteristics, silicon transistors such as the RCA 2N2270 or the Honeywell 2N1987 can be used.

OUTPUT VOLTAGES. The output voltage available is a function of the chosen frequency as well as the supply voltage to be used. Table 1 and table 2 can be used to determine what taps and head impedances should be used to best meet the design requirements. The supply voltage which has been chosen as 22.5 volts for table 2 data can be reduced to a value as low as 12 volts under some conditions. The designer will find it necessary to adjust bias resistors and other parameter sizes when operating at such a low voltage to insure proper erase head power.

OPERATING FREQUENCY. The frequency of the oscillator can be altered by the use of capacitor C_f . The reflected inductance of the load in combination with the primary inductance of the transformer in cooperation with C_f predominantly determines the operating frequency of the oscillator. In some cases the amplifier designer will find it desirable to resonate the output of the oscillator with a series capacitor C_e feeding the erase head (or heads). Under these conditions the erase head inductance and C_e will offer a purely resistive load to the secondary (and primary) of the transformer and therefore the oscillating frequency will essentially be determined by the resistive load-
ed, primary inductance of the transformer circuit alone. More about the use of resonant coupling will be given later.

PUSH-PULL TRANSISTORIZED BIAS-ERASE OSCILLATOR



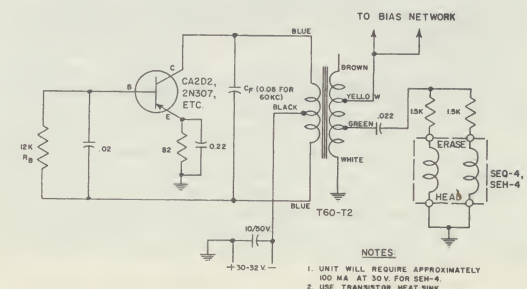
NOTES:

1. RESISTOR R_c SHOULD BE 1 WATT WHEN ABOVE 1000 OHMS.
2. C_f AND C_e CAPACITORS SHOULD BE MICA, PAPER OR OIL WITH 10% TOLERANCES.
3. IF HIGH IMPEDANCE RECORD HEAD IS USED WITH LOW IMPEDANCE ERASE HEAD, BIAS VOLTAGE CAN BE TAKEN FROM HIGHER TAP.

SINGLE-ENDED OSCILLATOR. The single-ended oscillator shown in the other included schematic is for specific operation at 60 kc; the frequency can be varied again by changing the value of C_f . The single-ended circuit will provide adequate performance for many applications. While it is possible to obtain better regulation and more power with the push-pull unit, circuit parts economy and space requirements will often dictate use of the single unit. Resistor R_b determines the operating bias of the transistor and will determine the output power available from the oscillator within a moderate range of adjustment. Care must be taken with this adjustment to avoid exceeding the operating ranges of the transistor.

ERASE HEAD COUPLING. As discussed briefly above, erase heads should be coupled to the secondary of the bias transformer in the manner shown in the push-pull schematic. When capacitor C_e is chosen to series resonate with the erase head at the operating frequency, there will be an increase in voltage noted across the erase head proper. The value of this voltage is approximately equal to the output voltage of the secondary times the operating Q of the erase head (for Nortronics erase heads, the resonant voltage is between 10% and 30% higher than the secondary voltage; this is shown in table 2 where C_e is chosen to be resonant with the head). This action of resonance also provides a small amount of filtering and thus can be used to enhance the waveform applied to the bias network. It should be pointed out that if the designer chooses a capacitor C_e larger than the resonant value, the degeneration in output waveform across the head will be negligible. The use of a variable pad capacitor for C_e will permit exact resonant tuning if desired.

SINGLE-ENDED TRANSISTORIZED BIAS-ERASE OSCILLATOR



NOTES:

1. UNIT WILL REQUIRE APPROXIMATELY 100 MA AT 30V FOR SEH-4.
2. USE TRANSISTOR HEAT SINK.

TABLE 2 T60-T2

F	HEAD TYPE	C _F MFD	C _C MMFD	R _C OHMS	TAP	I _{DC} (MA)	E _{DC}	E _S (AC)	E _H (AC)	I _H /SECT (MA)
60kc	SEQ-4	.055	1500	1000	G	140	22.5	38	46	14
60kc	SEH-4	.055	1500	120	G	190	22.5	33	48	22
60kc	SEQ-1	.055	150	1000	B	170	22.5	110	125	6
60kc	SEH-1	.055	240	330	B	170	22.5	110	125	7
80kc	SEQ-4	.03	650	47	G	140	22.5	40	60	14
80kc	SEH-4	.03	1500	0	G	160	22.5	36	50	22
100kc	SEQ-4	.02	650	0	Y	200	22.5	36	60	14
100kc	SEH-4	.02	650	0	G	175	22.5	40	52	22
60kc	MEF-4	.055	1500	0	G	150	22.5	40	45	40

Along with suggested values for parameters, table 2 gives center-value operating currents and voltages that will result with four basic popular Nortronics erase heads. This data was taken with short unshielded leads coupling the oscillator to the heads. If it is necessary to use shielded leads or even long unshielded leads, it may be necessary to alter some of the capacitor and resistor sizes.

THE T60-E TRANSFORMER

THE PUSH-PULL BIAS OSCILLATOR. The included schematic shows the T60-E used as a push-pull oscillator. This unit will provide a fully professional oscillator unit for the most critical applications. By making use of the data given in table 3 the designer can adapt the push-pull circuit for high impedance heads at 40, 50, 60 or 70 kc. A low impedance winding will provide power to several low impedance heads as shown in the dashed schematic addition.

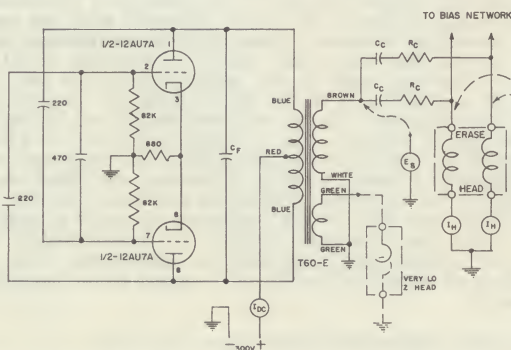
While the values shown in the table are only center-values, they will be within normal tolerances depending upon the components used, etc. For monaural use, the designer simply uses one section of the output as shown. The MEF1 being a full track head is, of course, a monaural head.

VACUUM TUBES. Vacuum tubes such as 12AU7A will provide performance well within dissipation ratings of the tubes when the supply voltage is under 300 volts. A tube such as the 12BH7 can supply slightly more erase power in special circuits.

OUTPUT VOLTAGES. The output voltage available is a function of the chosen frequency as well as the supply voltage to be used. The supply voltage which has been chosen as 300 volts for table 3 data can be reduced to a value as low as 150 volts under some conditions. The designer will find it necessary to adjust bias resistors and other parameter sizes when operating at such a low voltage to insure proper erase head power.

OPERATING FREQUENCY. The frequency of the oscillator can be altered by the use of capacitor C_F. The reflected inductance of the load in combination with the primary inductance of the transformer in cooperation with C_F predominantly determines the operating frequency of the oscillator. In some cases the amplifier designer will find it desirable to resonate the output of the oscillator with a series capacitor C_C feeding the erase head (or heads). Under these conditions the erase head inductance and C_C will offer a purely resistive load to the secondary (and primary) of the transformer and therefore the oscillating frequency will essentially be determined by the resistive loaded, primary inductance of the transformer circuit alone. More about the use of resonant coupling will be given later.

40KC TO 70KC BIAS-ERASE OSCILLATOR USING T60-E



ERASE HEAD COUPLING. As discussed briefly above, erase heads should be coupled to the secondary of the bias transformer in the manner shown in the push-pull schematic. When capacitor C_C is chosen to series resonate with the erase head at the operating frequency, there will be an increase in voltage noted across the erase head proper. The value of this voltage of the secondary times the operating Q of the erase head (for Nortronics erase heads, the resonant voltage is between 10% and 30% higher than the secondary voltage; this is shown in table 3 where C_C is chosen to be resonant with the head). This action of resonance also provides a small amount of filtering and thus can be used to enhance the waveform applied to the bias network.

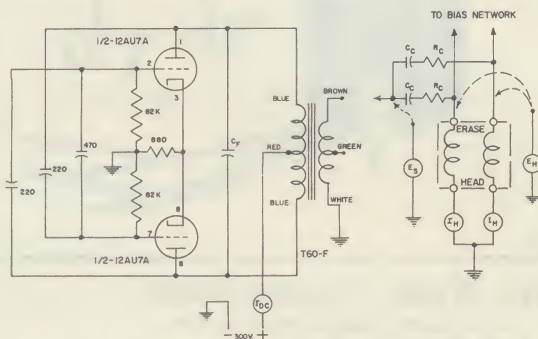
TABLE 3 T60-E

F	HEAD TYPE	C _F MMFD	C _C MMFD	R _C OHMS	TAP	I _{DC} (MA)	E _{DC}	E _S (AC)	E _H (AC)	I _H /SECT (MA)
40kc	SEQ-1	330	470	10k	B	10	300	120	120	6
50kc	SEQ-1	150	220	8.2k	B	9	300	125	140	6
60kc	SEQ-1	68	120	6.8k	B	8	300	125	135	6
70kc	SEQ-1	0	100	2.2k	B	7.5	300	125	140	6
40kc	SEH-1	330	470	3.9k	B	10	300	115	115	7
50kc	SEH-1	150	220	2.2k	B	8	300	130	125	7
60kc	SEH-1	47	120	2.2k	B	9	300	120	135	7
70kc	SEH-1	0	100	1k	B	9	300	120	132	7

THE T60-F TRANSFORMER

THE PUSH-PULL BIAS OSCILLATOR. The included schematic shows the T60-F used as a push-pull oscillator. This unit will provide a fully professional oscillator unit for the most critical applications. By making use of the data given in Table 4 the designer can adapt the push-pull circuit for high impedance heads at 70 kc and low impedance heads at 80, 90, and 100 kc.

70KC TO 100KC BIAS-ERASE OSCILLATOR USING T60-F



VACUUM TUBES. Vacuum tubes such as 12AU7A, 12AV7, or the 12AT7, will provide performance well within dissipation ratings of the tubes when the supply voltage is under 300 volts. A tube such as the 12BH7 can supply slightly more erase power in special circuits.

OUTPUT VOLTAGES. The output voltage available is a function of the chosen frequency as well as the supply voltage to be used. The supply voltage which has been chosen as 300 volts for Table 4 data can be reduced to a value as low as 150 volts under some conditions. The designer will find it necessary to adjust bias resistors and other parameter sizes when operating at such a low voltage to insure proper erase head power.

OPERATING FREQUENCY. The frequency of the oscillator can be altered by the use of capacitor C_F. The reflected inductance of the load in combination with the primary inductance of the transformer in cooperation with C_F predominantly determines the operating frequency of the oscillator. In some cases the amplifier designer will find it desirable to resonate the output of the oscillator with a series capacitor C_C feeding the erase head (or heads). Under these conditions the erase head inductance and C_C will offer a purely resistive load to the secondary (and primary) of the transformer

TABLE 4 T60-F

F	HEAD TYPE	C _F MMFD	C _C MMFD	R _C OHMS	TAP	I _{DC} (MA)	E _{DC}	E _S (AC)	E _H (AC)	I _H /SECT (MA)
70kc	SEQ-1	200	100	3.9k	B	12	300	150	160	6
80kc	SEQ-4	125	1000	1.5k	G	11	300	52	58	15
90kc	SEQ-4	47	470	1.5K	G	11	300	58	62	15
100kc	SEQ-4	0	470	1.5K	G	10	300	60	70	15
70kc	SEH-1	200	100	1k	B	13	300	140	150	7
80kc	SEH-4	125	1000	470	G	13	300	48	55	22
90kc	SEH-4	47	1000	470	G	12	300	49	59	22
100kc	SEH-4	0	470	470	G	11	300	50	60	22
70kc	MEF-4	200	1000	220	G	11	300	50	55	45

ERASE HEAD COUPLING. As discussed briefly above, erase heads should be coupled to the secondary of the bias transformer in the manner shown in the push-pull schematic. When capacitor C_C is chosen to series resonate with the erase head at the operating frequency, there will be an increase in voltage noted across the erase head proper. The value of this voltage is approximately equal to the output voltage of the secondary times the operating Q of the erase head (for Nortronics erase heads, the resonant voltage is between 10% and 30% higher than the secondary voltage; this is shown in Table 4 where C_C is chosen to be resonant with the head). This action of resonance also provides a small amount of filtering and thus can be used to enhance the wave form applied to the bias network.



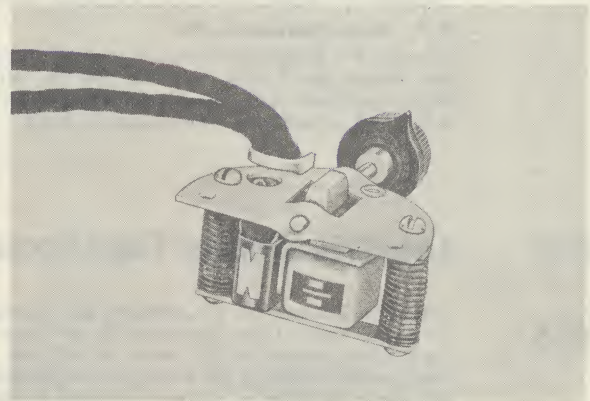
Nortronics® QUALITY 4-TRACK STEREO CONVERSION KITS

THE NORTRONICS COMPANY, INC. 8101 TENTH AVENUE NORTH MINNEAPOLIS, MINNESOTA 55427

WR-60 Converts All Wollensak and Later Revere Monophonic and 2-Track Stereo Recorders to 4-Track Stereo

The **WR-60** is a 4-Track Stereo Conversion Kit of advanced design consisting of a 4-track stereo record/play head and a 4-track stereo erase head mounted in a head shifting mechanism. Rotation of the shifter control knob provides three vertical positions of the head assembly, permitting playback of both 2 and 4-track pre-recorded tapes and recording of 4 monophonic tracks on a single tape. Also, sound with sound recordings may be made with a single recorder. Stereo recording with the **WR-60** is possible by using an additional recording amplifier such as the Nortronics **RA-100**.

The **WR-60** is supplied completely wired and assembled for ready installation in the tape recorder. The conversion can be performed by a reasonably skilled person with a set of hand tools, including a soldering iron, or by a service shop.

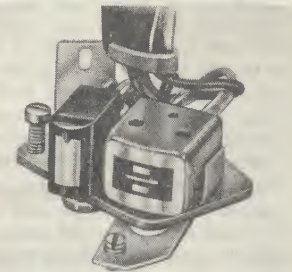


Complete assembly of Nortronics 4-track stereo R/P and erase heads

WR-40 Converts All Wollensak and Later Revere Monophonic Tape Recorders to 4-Track Stereo Playback

Direct replacement of the present monophonic head assembly by the stereo unit of the **WR-40** Kit converts the tape recorder to 4-track stereo playback. Monophonic record/playback capabilities are retained. The stereo head is a first-line, fine gap record/play tape head. It will provide unsurpassed high-fidelity playback of pre-recorded 4-track tapes.

The stereo record head and monophonic erase head are mounted on a brass plate, and include connecting cables. The second sound channel is brought out through a miniature phone jack. A patch cord is furnished to make connection to an external audio amplifier.



View showing the stereo head assembly of the **WR-40** Kit properly positioned in the head cup of the recorder.

V-6 Stereo Conversion Kits for All 700 Series VM Tape Recorders

V-7

THE NORTRONICS CO., INC. offers first-line 4-track (quarter-track) stereo heads in convenient conversion kits for V-M recorders. Superior high frequency response and reduced hum pickup are features of these heads, which have professional type laminated cores. All V-M Recorders may be converted to 4-track stereo playback with the **V-6** kit. In all cases, the original monophonic record/playback capabilities are retained. All V-M Recorders may be converted to 4-track stereo erase/record/playback with the **V-6** kit, plus the **V-7** erase kit, plus an external recording amplifier, such as the Nortronics **RA-100**.

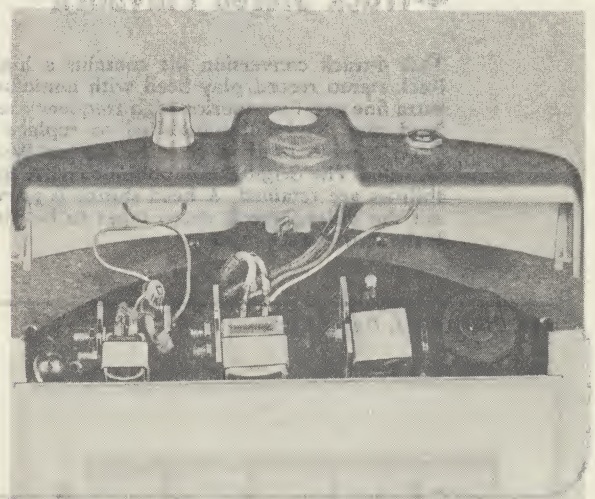
V-6 Conversion Kit.

Converts all V-M machines to 4-track stereo playback. Retains the present two-channel monophonic recording and playback facilities by using present monophonic half-track erase head. Stereo erase for stereo recording requires the **V-7** erase conversion kit listed below.

V-7 Erase Conversion Kit.

Replaces monophonic erase head with 4-track erase head to permit stereo recording. To be used in conjunction with the **V-6** Kit described above.

The combined **V-6** and **V-7** conversion kits may be used for both stereo and monophonic four-track recording with the assistance of an external recording amplifier, such as the Nortronics **RA-100**.



Complete assembly properly positioned in the recorder.

P-6 Converts Pentron Tape Recorders to 4-Track Stereo

P-7

The NORTRONICS CO., INC. supplies its first-line 4-track (quarter-track) stereo heads in convenient conversion kits for Pentron recorders. Superior high frequency response and reduced hum pickup are features of the Nortronics heads, which have professional type laminated cores.

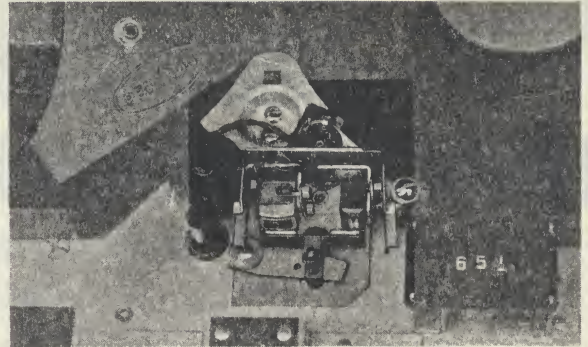
All Monophonic and 2-Track Stereo Pentron recorders may be converted to 4-track stereo playback with the P-6 kit. The ability to record and play back monophonic material is retained.

P-6 Conversion Kit.

Converts the Pentron to 4-track stereo playback. Retains the present two-channel monophonic recording and playback facilities by using present monophonic half-track erase head. Stereo erase with stereo recording requires P-7 erase conversion kit listed below.

P-7 Erase Conversion Kit.

Use the P-7 Erase Conversion Kit on all Pentron recorders except the XP-60, XP-60S, and the NL-4. For the latter machines order the Nortronics 4-track stereo erase head, low impedance, *side mounting* style.



Typical installation showing the Nortronics 4-track stereo R/P head (from P6 kit) in place of the previous monophonic head. The erase head at the right is the Nortronics 4-track stereo erase head from the P-7 kit, and replaces the previous monophonic erase head for stereo recording. If stereo recording is not required only the record head is replaced, and the present monophonic erase head is retained.

W-2 Converts Webcor Tape Recorders to 4-Track Stereo

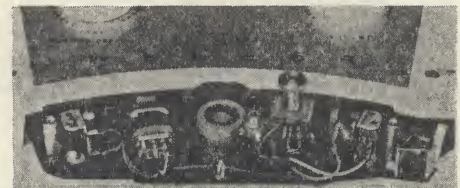
W-6

The W-6 Conversion Kit converts all Monophonic* and Stereo Webcor Tape Recorders in the older 2800, 2900, and 2000 (except 2020) series to 4-Track Stereo playback while retaining all existing monophonic record and playback facilities. A convenient head shifter allows the 4-Track head to be positioned readily for both 2-Track and 4-Track tapes. The NORTRONICS 4-track record/play head has laminated cores for superior high frequency response and long wear life. Completely assembled and ready to install.

*Monophonic machines need a phone jack and patch cord set to bring out the second stereo channel to an external tape playback amplifier. The Nortronics Model PC-100 is recommended. It includes a miniature shorting-type phone jack and a 24-inch patch cord with miniature phone plug on one end and phono plug on other end.

The W-2 Conversion Kit converts all Webcor Tape Recorders in the older 210, 2020, 2100, 2600 and 2700 series to 4-Track Stereo Playback.

The W-2 Conversion Kit consists of a high quality 4-track stereo playback head and bracket assembly which may be used to replace the monophonic head assembly in the above series of Webcor tape recorders.



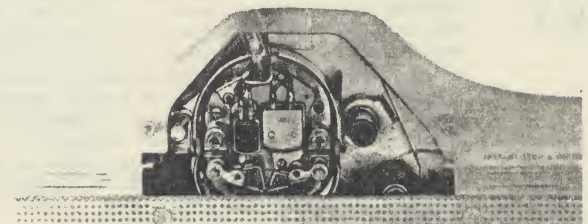
View showing the W-6 Conversion Kit installed on a Webcor two-direction recorder. The present monophonic erase head is left in place.



W-2 installed in place of the right hand head assembly on a two-direction Model 2130 tape recorder.

WR-35 Converts Wollensak and Revere Recorders from 2-Track Stereo to 4-Track Stereo Playback

This 4-track conversion kit contains a high quality 4-track stereo record/play head with laminated cores and extra fine gap for superior high frequency response. This head may be readily installed to replace the present 2-track stereo head in your Revere or Wollensak tape recorder. The original monophonic record/playback capabilities are retained. A head shifter is provided to permit the older 2-track stereo tapes to be played as well as the new 4-track tapes.



Top view of head nest, showing new 4-track stereo head mounted to right of present erase head.

YOUR LOCAL DEALER:



Nortronics®

CUSTOMER ENGINEERING BULLETIN

THE NORTRONICS COMPANY, INC. 8101 TENTH AVENUE NORTH MINNEAPOLIS, MINNESOTA 55427

3.75 INCH PER SECOND TAPE OPERATION

7.5 IPS PERFORMANCE

At the present time a speed of 7.5 IPS will provide excellent performance in a well designed tape recorder. Frequency response can be extended beyond 15 kilocycles with comparative ease and if care is taken to insure good tape guiding and head-to-tape contact, track widths as small as 0.043", such as used on the standard quarter-track system, will provide usable dynamic range up to 50 db. It is true that 15 IPS is used for most master tape recordings, but this is to insure a minimum fidelity loss when rerecording masters for duplication.

3.75 IPS PERFORMANCE

The Nortronics Company is often asked how 3.75 IPS performance compares with 7.5 IPS. This is difficult to evaluate because several factors enter into the picture. Frequency response, usable dynamic range (signal-to-noise ratio without excessive distortion), distortion and effects of high frequency erasure are all important and related. The following paragraphs will explain some of the factors necessary to design a good 3.75 IPS tape system.

With a given tape, record/play head, handler and amplifier, it is necessary to compromise performance when speed is reduced. Frequency response can be partially retained by using reduced bias and by altering the playback and/or record equalization of the amplifier. Dynamic range can be partially retained by not reducing the bias.

It is apparent, then, that a conflict exists which will require the designer to compromise by making only a modest bias reduction and accepting the reduced dynamic range.

DESIGN FACTORS IN SPEED REDUCTION FROM 7.5 TO 3.75 IPS

The heavy solid curve in Figure 2-1 illustrates constant current at reference level, unequalized record/playback response for the new Nortronics B2Q type quarter-track heads at 7.5 IPS at peak bias (peak bias is the bias current that will give a maximum 1 kc signal at reference recording current level, which is appropriately 12 db. below tape saturation at 1 kc.).

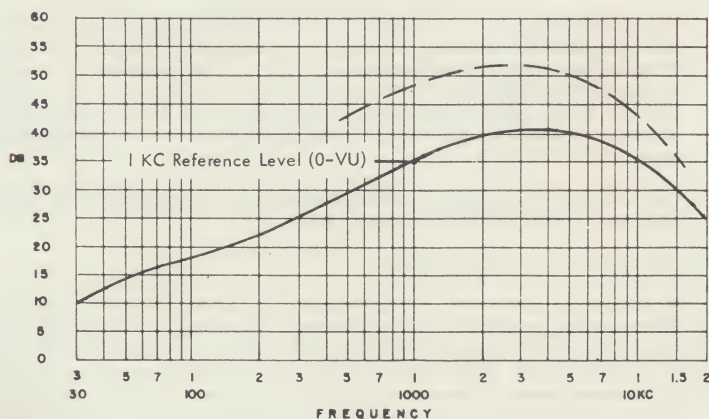


FIGURE 2-1 Constant current record, unequalized playback at a level 12 db below tape saturation at peak bias for 1 kc at 7.5 inches per second. The dashed curve is the tape recording level (just below tape saturation). Distortion at reference level at 1 kc is approximately 2 percent. In many cases, reference level or "0-VU" level is determined at a specific distortion level such as 2 percent.

The light curve in Figure 2-1 is the level just below tape saturation. This means that 12 db. more output can be obtained at 1 kc., 10 db. more at 10 kc., 7 db. more at 15 kc., etc. Figure 2-2 shows the same type of curves for 3.75 IPS at the 3.75 peak bias figure. It is interesting to note that the reserve at 10 kc. has now fallen to only 3 db.

Examining Figure 2-1 more closely on 7.5 IPS operation will bring this information to light: The maximum recording current at 1 kc. is 12 db. above reference level. The maximum record current at 15 kc. is about 7 db. above reference level. Therefore, the maximum current at 15 kc. is approximately 12 minus 7, or 5 db. lower than the maximum recording current at 1 kc. Similarly, referring to Figure 2-2 at 3.75 IPS will show that the maximum recording current at 1 kc. is 12 db. higher than reference level and the maximum recording current at 10 kc. is 3 db. above reference level. Therefore the 10 kc. maximum recording current must be 12 minus 3, or 9 db. lower than the maximum recording current at 1 kc.

This data can be used to show how the recording level at 7.5 IPS is limited to about 8 db. below reference level to obtain flat response to 15 kc. and at 3.75 IPS to about 11 db. below reference level to obtain flat response to 10 kc. Figure 2-3 shows the NAB type, 7.5 IPS playback curve already discussed (Figure 2-1), the resulting recording curve of Figure 2-4 will be needed to produce flat system response to 15 kc. Examining Figure 2-4 reveals that a boost of approximately 15 db. is needed at 15 kc. relative to the 1 kc. level.

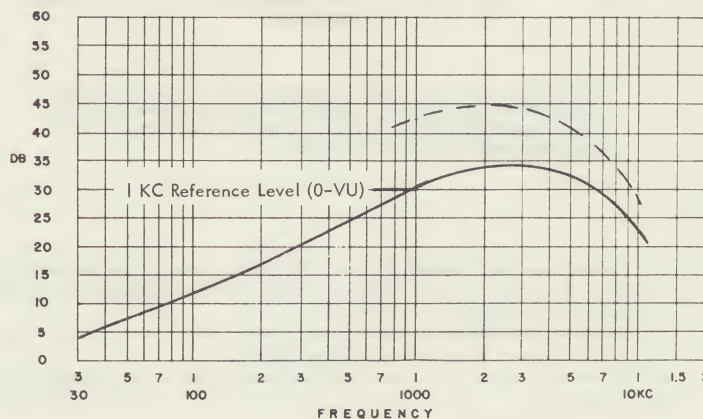


FIGURE 2-2 Constant current record, unequalized playback at 12 db below saturation at peak bias for 1 kc at 3.75 inches per second. Light (dashed) curve is just below tape saturation.

Then, since Figure 2-1 indicated a reserve of only 7 db. exists at 15 kc. when reference level record current is used, it follows that the operating level of the system must be reduced to 15 minus 7, or 8 db. below reference level if flat response to 15 kc. is desired. This will explain why recorder frequency response curves must be run at a level well below "0 VU" to obtain full performance.

At 3.75 IPS the constant current curve of Figure 2-2 indicates a decrease in response at 10 kc. relative to 1 kc. of about 10 db. (in contrast to the equal response of 1 kc. and 10 kc. for 7.5 IPS - Figure 2-1). This additional response drop can be made up by increasing the playback curve (Figure 2-3 dashed curve), by 6 db. at 10 kc. and the record curve (Figure 2-4 dashed curve), by 4 db. As seen in Figure 2-4, an approximate 14 db. boost is necessary at 10 kc. relative to 1 kc. and with a reserve of only 3 db. at 10 kc., it will be necessary to limit the operating level to 14 minus 3 equals 11 db. below reference level if a flat response to 10 kc. is desired.

In summing up, the 7.5 IPS system can provide flat response to 15 kc. at approximately 8 db. below reference level. The 3.75 IPS system can provide flat response to 10 kc. at about 11 db. below reference level. This is graphically illustrated in Figure 2-5. The designer must be fully aware that this simplified technical discussion does not take into account the wide variations that will be caused by tape quality, head alignment, tape-head contact, etc.

A music recording session where an unusual amount of high-level, high-frequency audio energy is generated can severely overload even a 7.5 IPS system unless the recording level is appropriately monitored. At 3.75 IPS it is, of course, more critical. If the level is not lowered, the frequencies in the upper range that overlap into saturation will simultaneously erase the lower frequencies and produce severe distortion. Fortunately, a large percentage of music does not make such demands on a recording system and therefore 3.75 IPS operation will usually give good performance for audiophile and home use as well as in background music and other commercial uses.

One interest point should be brought up: Most non-professional machines have a base noise level limited by amplifier noise or inadequate auxiliary shielding. Thus, it is often possible to enhance signal-to-noise ratio of a recorder at both 3.75 and 7.5 IPS by simply improving the amplifiers and head shielding. In the case of a professional, high-quality recorder where the base noise level is from the tape, it will be necessary to await further tape oxide developments in order to improve dynamic range characteristics.

In review, the following steps are recommended to obtain good performance at 3.75 IPS with Nortronics quarter-track, 100 micro-inch record/play heads.

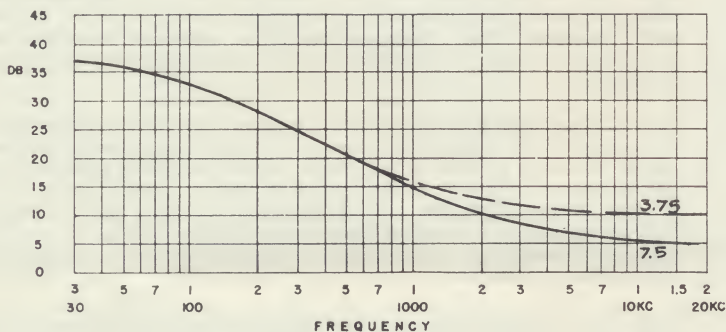


FIGURE 2-3 Playback amplifier response for 7.5 and 3.75 inches per second tape speeds. The 7.5 ips curve is the NAB response. It is almost universally used for playback at 15 and 7.5 ips. There is no official standard for 3.75 and 1.875 ips.

- (1). Reduce the bias current to the 3.75 peak. This is approximately 80 to 85% of the peak 7.5 IPS bias as given on the individual specification sheet for the head type being used.
- (2). Reduce the record current to about 80 to 85% of the 7.5 IPS reference level as given in the specification sheet.
- (3). Alter the playback and record amplifier response as shown in Figure 2-3 and 2-4.

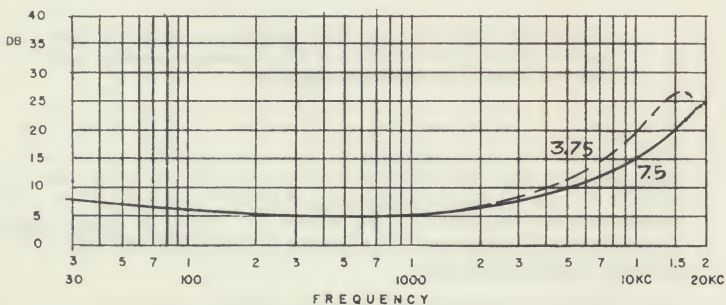


FIGURE 2-4 Record amplifier response for 7.5 and 3.75 inches per second tape speeds.

1.875 IPS OPERATION

The use of 1.875 ips should be approached from two directions. The first is when the designer wants to use the low speed as a "voice" mode or simply a third speed for tape economy with 3.75 and 7.5 ips being used for quality recording.

The second approach is when the designer is willing to utilize the latest tape technology, fine-gap heads, careful tape handling, and low-noise amplifier design. Under these circumstances it is possible to achieve true high-fidelity performance at 1.875 ips.

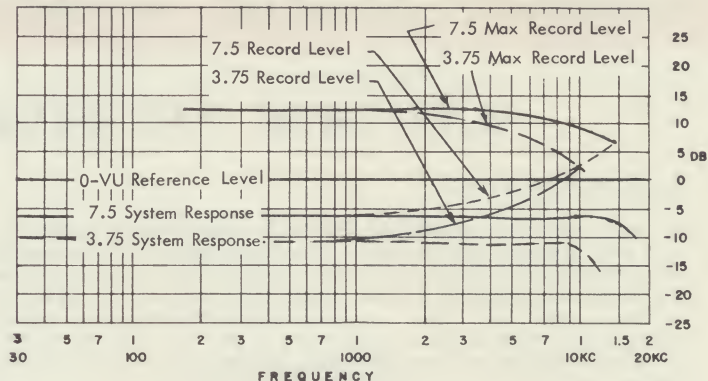


FIGURE 2-5 System response curves for fully equalized 7.5 and 3.75 ips operation. These response curves are shown at the maximum level that can be recorded to give 15 kc at 7.5 ips and 10 kc at 3.75 ips. The corresponding record amplifier curves are also shown as a matter of interest to indicate the maximum levels (at the intersections of the record current curves and the maximum record level curves at 15 kc for 7.5 ips and 10 kc for 3.75 ips).

It should be noted here that a compromise must be made in the playback head gap in order to handle a three octave speed range; a head suitable for best performance at 7.5 ips requires a gap of approximately 100 to 200 microinches. For 3.75 ips operation the playback gap should be between 80 and 160 microinches. At 1.875 the gap should be between 30 and 70 microinches for optimum performance with the latest tape for high-density recording.

The Nortronics F gap, which is 50 microinches, is ideally suited for the second approach at 1.875 ips. The gap loss on playback is small enough so that 15 kc. (125 microinch wavelength) can be effectively reproduced at this speed.

Special tape has now been developed which has an extremely smooth oxide surface. This very smooth surface results in intimate contact between the head gap and the tape. In addition the new tape has a very uniform thickness and a low friction surface characteristic to reduce flutter and noise.

The choice of bias in an optimum 1.875 ips system is even more critical than that described in the preceding paragraphs for 3.75 ips. The compromise bias chosen for response up to 15 kc. is an optimum or peak bias at about 5 kc. Under these conditions the bias field does not take full advantage of the coating efficiently at low frequencies and correspondingly the high frequencies will be slightly attenuated due to overbias-demagnetization.

In a forthcoming Customer Engineering Bulletin operation at 1.875 ips for optimum fidelity will be covered in detail.

1.875 IPS VOICE OPERATION

As mentioned above this mode is generally a compromise to provide a third economy speed for voice recording. Assuming 7.5 ips and 3.75 ips are also used the designer should choose a bias of about 60 to 70% of the 7.5 ips peak bias. About 70 to 75% of the 7.5 ips reference level recording current should be used for 1.875 ips 0VU level. At 8 kc. the recording current should be boosted about 12 to 15 db. above the 1 kc. level; this will provide good system response to approximately 6 to 7 kc. with Nortronics 100 microinch gaps providing the user keeps the recording level at least 15 db. below reference level.

If any further information is desired on slow speed operation write to: THE NORTRONICS COMPANY, INC., CUSTOMER SERVICE DEPARTMENT, 8101 10th AVENUE NORTH, MINNEAPOLIS 27, MINNESOTA



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CUSTOMER ENGINEERING BULLETIN

THE NORTRONICS COMPANY, INC. 8701 TENTH AVENUE NORTH MINNEAPOLIS, MINNESOTA 55427

HEAD WEAR, ALIGNMENT AND CARE

HEAD WEAR AND ALIGNMENT

When a tape recorder is properly designed, and when the tape guiding components (guides, head, pressure pads, capstan roller, reel plates, etc.) are properly adjusted and maintained, it is then--and only then--that the owner will get full performance characteristics from the magnetic recording process. Since even the use of premium quality tape will eventually wear the recording and erase heads, it is especially important to clean, maintain adjustment, and eventually replace heads when the electrical characteristics of the head are excessively altered by tape wear. The following information will be of interest to tape machine owners concerned with head wear and alignment.

TAPE-TO-HEAD CONTACT, TAPE GUIDING, AND ALIGNMENT

When the head gap is out of alignment in azimuth, or in other words when the gap is not perpendicular to the direction of tape motion, there can be a serious loss in high frequencies. This is especially true when the machine is called upon to play back a standard, pre-recorded tape that has been made on a recorder or duplicator with proper azimuth alignment. To illustrate the importance of azimuth alignment, if a fully aligned 7500 cycle per second tape is played back on a half-track machine at 7.5 inches per second, it will be found that an azimuth mis-alignment of only $1/3^\circ$ will reduce the playback signal to one-half of its proper level.

With this in mind the reader should also recognize that any skewing (vertical tape walk) resulting from wobbly reels or over-sized guides can easily cause a cyclic or random off-and-on state of azimuth alignment even if the head gap is aligned to the nominal tape position. This is shown in Fig. 3-1. If the plane of the face of the head is not aligned parallel to the tape guiding plane (see Fig. 3-2), a tendency to skew or "walk" will also result.

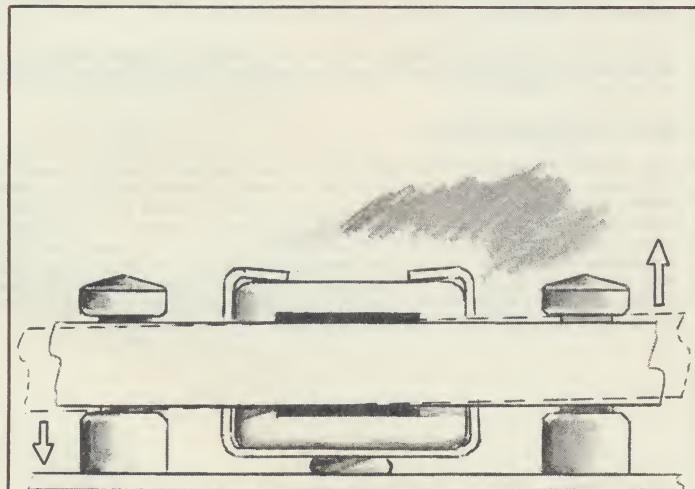


FIGURE 3-1: Showing how excessive reel wobble (motion indicated by arrows) especially with worn, oversize tape guides can cause the tape (dotted-curve) to deviate in azimuth even though the head is properly aligned.

PRESSURE PADS

As discussed in CEB number 1, many tape machine manufacturers choose to use fabric or felt pressure pads that apply pressure to the back (shiny side) of the tape at the area that is immediately in contact with the recording head gap. This is shown in Fig. 3-3. The pressure pad approach is a simple, effective, relatively inexpensive, and yet potentially troublesome method of obtaining intimate tape-to-head contact. One undeniable asset of the pressure pad lies in the fact that wrinkled, mistreated tape can generally be made to pass across the head gap and give satisfactory record and playback performance. An important liability is the fact that head wear is greatly accelerated and usually in a manner that results in unequal wear across the width of the head. This unequal wear is a result of the pad not providing uniform pressure across the width of the tape and

Angle of deviation
from true perpendicular

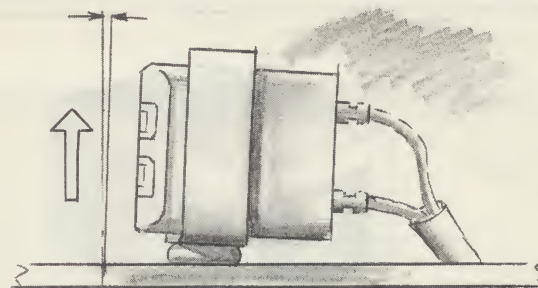


FIGURE 3-2: If head face plane is not parallel to true perpendicular, tape will tend to skew in direction of arrow.

it frequently causes craters or ripples to form in the head surface as shown in Fig. 3-4. It can cause the tape to lose contact with part or all of the head gap. Increased complications will result if oxide deposits build up in the craters.

Another detrimental condition results when a machine is equipped with a quarter-track stereo head that is mechanically moved up and down to place the head from the "quarter-track" to the "half-track" or centered position. In this case, unless the owner almost equally divides machine time between the two modes, a groove will wear in the head that corresponds to the track position that is favored. Again, if pressure pads are used, the grooves will be worn even faster into the head surface.

PERFORMANCE DETERIORATION

As the head wears, several changes occur in the operational characteristics. These changes take place on a gradual, continuing basis.

On record:

- (1). Peak bias current requirement decreases.
- (2). Inductance decreases.
- (3). Actual bias current increases.
- (4). Record sensitivity increases.
- (5). Record current slightly increases.
- (6). Gap linearity frequently decreases and finally the gap abruptly opens.

On playback:

(1). Playback sensitivity generally increases; high frequency response relative to low frequency response increases and then abruptly reverses as the gap opens.

In the record process, (1) and (3) aid each other to reduce high frequency

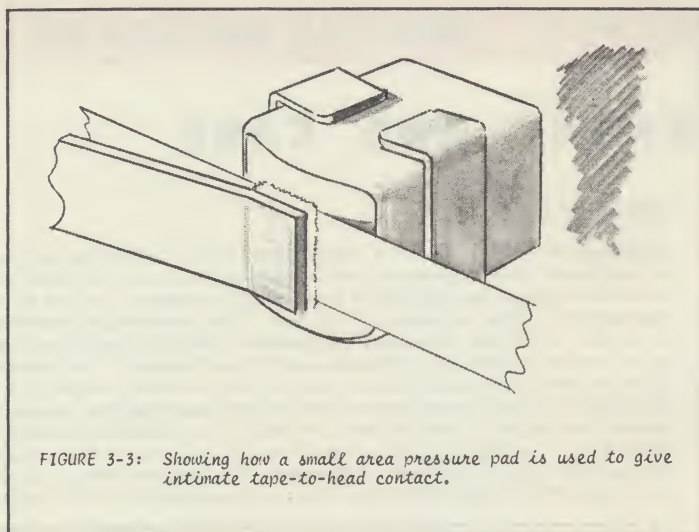


FIGURE 3-3: Showing how a small area pressure pad is used to give intimate tape-to-head contact.

system response by producing an over bias. In the case of many home machines, a bias control is not provided and the machine cannot be compensated for high frequency losses to maintain proper performance.

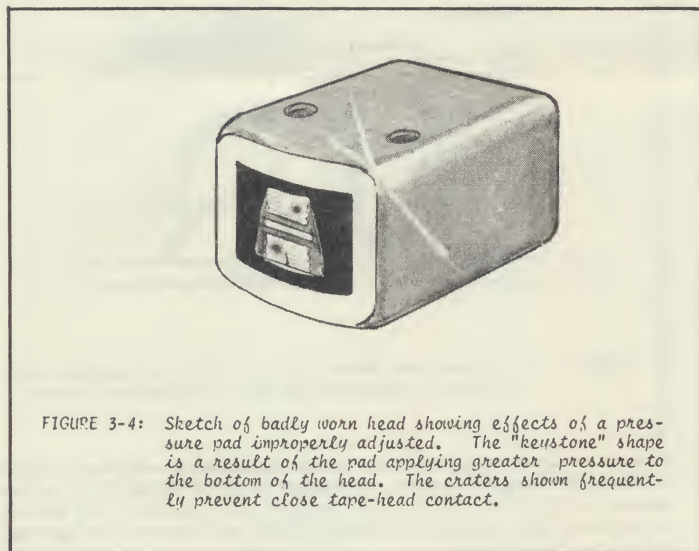


FIGURE 3-4: Sketch of badly worn head showing effects of a pressure pad improperly adjusted. The "keystone" shape is a result of the pad applying greater pressure to the bottom of the head. The craters shown frequently prevent close tape-head contact.

HEAD LIFE

Head life is highly dependent upon the design factors of the recorder involved. For example, the differences in head wear with and without pressure pads can sometimes be an order of magnitude (a factor of ten)! If a machine makes use of a relatively small area pressure pad, and if the pressure pad has an applied force of greater than one-half ounce, head life can be as low as 300 or 400 hours of recording or playback operation time. On the other hand, if a machine does not use pressure pads, and if the tape guides are smooth, and the depth of metal at the record gap is sufficiently large, 3000 to 4000 hours of operation can be expected. The table shown in Fig. 3-5 will provide an approximate guide to permit the machine owner to judge performance time before expecting to notice losses in performance from head wear. It must be pointed out that a premium tape from a reputable manufacturer will also greatly reduce problems from head wear. Of interest too is the fact that re-use of the same tape produces less abrasion on the tape head than an equal amount of time with "fresh" tape.

HEAD CARE

A magnetic tape head deserves the same attention that a high quality phonograph cartridge and needle assembly requires. The head core material is almost always made of a high nickel-content alloy steel. This material, called Mu metal, Hy Mu-80, etc. is annealed (heat treated) to provide maximum performance characteristics for magnetic recording. This process, unfortunately, reduces the core material to a state of mechanical "softness". In view of this, it is necessary that the tape recorder owner exercise caution in cleaning the head face. Specifically, lens paper

PRESSURE PADS	TAPE LIFTERS	DOMINANT SPEED 1,875 3,75 7,5			PROBABLE HEAD LIFE	COMMENTS
Yes	Yes			*	500-600 hrs	Life depends greatly upon such factors as condition of tape, make of head and even ambient dust and hu- midity . . .
Yes	No			*	300-400 hrs	
Yes	No		*		500-600 hrs	
Yes	No	*			700-800 hrs	
No	No			*	1000-2000 hrs	
No	Yes			*	2000-4000 hrs	

FIGURE 3-5: Table showing very approximate head wear figures for high-nickel alloy cores (laminated or single laminar) in a plastic or die-cast core holder. Special alloys such as Alfenol do not give satisfactory permeability for use as high performance magnetic heads even though it is somewhat "harder" mechanically.

or a cotton swab device such as a Q-Tip would be ideal for this operation. Pipe cleaners or any device such as a stiff bristle brush can easily ruin the magnetic head surface and should never be used.

The use of solvents for cleaning purposes should be restricted to those products that will not in any way react with the resins, plastic surfaces, or metal surfaces of the head. One recommended cleaner would be Long-Life. The Long-Life kit contains two separate products. First, a cleaning solution that contains several solvents to dissolve deposited oxide material, grease, and other foreign particles. The cleaner solution if used according to directions will not harm epoxy resin, core metals, face metals or plastic materials used in the head construction. This same cleaner should be used on the tape guides, capstan shaft, and pressure rollers; the solvents will not in any manner affect the characteristics of rubber or neoprene.

The second solution in the Long-Life kit is a silicon cleaner that will disperse a thin coat of lubricant by capillary action. A small pylon dispenser is included with the kit.

HEAD MAGNETIZATION

One of the most important factors in retaining low noise and good high frequency performance characteristics results from keeping recording heads thoroughly demagnetized. This can best be done by using a small head-demagnetizer designed specifically for this purpose. It usually has soft, plastic-coated tip which will adequately protect the head from being scratched or marred. Frequent demagnetizing by this means has a two-fold beneficial purpose: (a) Valuable recorded tapes will not be superimposed with recorded noise, and (b) high frequency playback performance of the machine will generally be enhanced.



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CUSTOMER ENGINEERING BULLETIN

THE NORTRONICS COMPANY, INC. 8101 TENTH AVENUE NORTH MINNEAPOLIS, MINNESOTA 55427

THE VACUUM TUBE PLAYBACK PREAMPLIFIER

GENERAL INFORMATION

The vacuum tube still holds a predominant position in tape recorder amplification. This is due to the large amount of design experience that has been gained in vacuum tube circuits and also to the large number of inexpensive, low-noise tubes that are currently available to the designer.

The tape recorder preamplifier must be designed with the following points in mind:

- Signal-to-noise ratio must be as high as possible; on professional equipment, tape noise should be the limiting factor in the amplifier.
- Equalization should permit flat system response with a tape pre-recorded to NAB or similar standards.
- It should be stable, and if possible, feedback should be used to reduce gain variations due to tube aging.

THE PENTODE PREAMPLIFIER

The high gain, low-noise linear pentode has been used extensively in tape recording playback amplifiers. The schematic in Figure 6-1 shows a typical pentode unit designed for use with NAB playback equalization. The increased input impedance which is inherent in the pentode tube permits the designer to use very high inductance playback heads without degeneration at higher frequencies. The schematic shows a .01 capacitor and a 20 k potentiometer in a simple shunt equalizer. The value of the capacitor is chosen so that the absolute value of its capacitive reactance is equal to the effective pentode output impedance at a frequency which is between 20 and 60 cycles depending upon low frequency characteristics of the playback head being used. The value of the 20 k potentiometer is determined by the high frequency performance of the head, the tape speed being used, and so on. An NAB type curve is shown in Figure 6-2. This is repre-

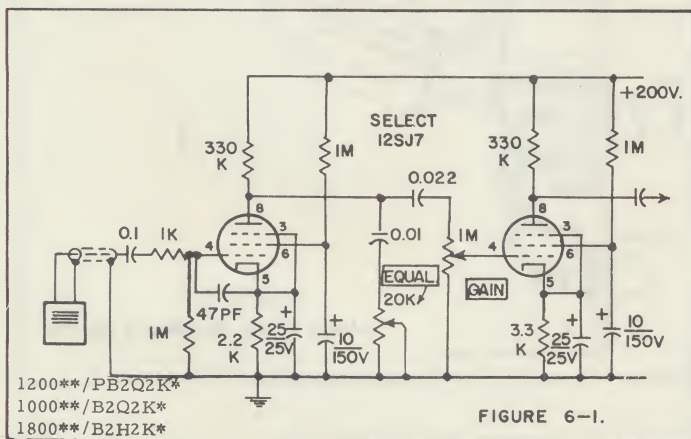


FIGURE 6-1.

sentative of the typical amplifier playback response at 7.5 inches per second. Since there is no feedback used in this amplifier, the overall gain of the amplifier will be directly affected by the condition of the tubes.

THE TRIODE PREAMPLIFIER

The amplifier shown in Figure 6-3 is a triode unit with the equalization applied in a feedback circuit from the plate of the second stage to the cathode of the first stage. A simple method of determining the value of the feedback parameters will be described: First, the gain of the two stage amplifier without feedback is determined at 1kc (this gain is shown in Figure 6-2 at A). A feedback network consisting of the 500k potentiometer and a large capacitor (0.1 mfd, for example) is connected in series between the second stage plate and the first stage cathode; the potentiometer is then adjusted until the gain is 35db below the open-loop gain (this is B in Figure 6-2). The 0.1 mfd capacitor is now experimentally reduced in value until the response at 1kc is 25 db below the open-loop gain (this is C in Figure 6-2).

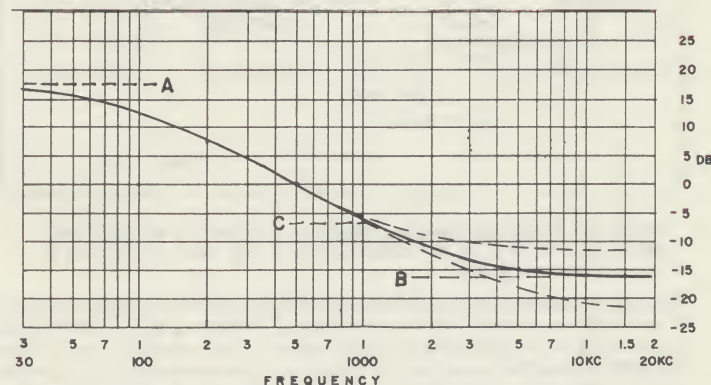


FIG 6-2 Typical NAB type amplifier response for 7.5 ips playback; dashes show limits obtained by variation of equalizer for head differences.

The capacitor value determined in the above manner is approximately 750 mmfd. The corresponding potentiometer value is 50 K; the dashed curves shown in Figure 6-2 result when the resistance is varied to compensate for head response characteristics.

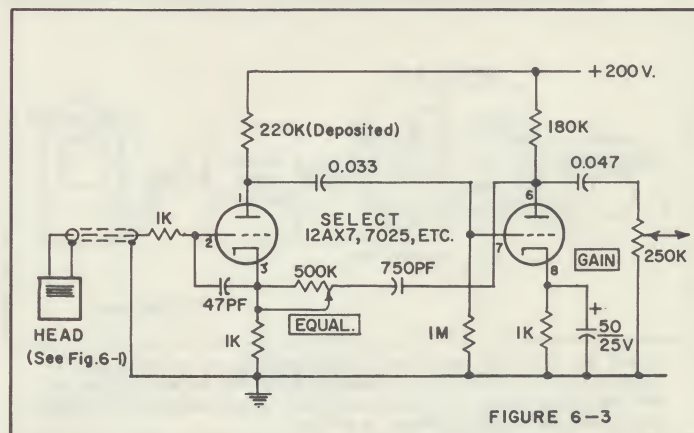


FIGURE 6-3

Although the triode has a much greater grid plate capacitance than a pentode, the use of equalization by feedback serves to raise the impedance to a sufficiently high value that will permit the use of high inductance playback heads. The feedback also helps to make the amplifier gain less dependent upon tube conditions at higher frequencies.

HEAD RESONANCE

It should be noted here that the wiring capacitance between adjacent turns and layers, especially on a high inductance playback head, can become a liability in tape recorder playback performance. This occurs when the self-inductance of the head and its associated wiring capacitance are high enough in value to form a parallel resonance in or near the high audio frequency limits. A rule of thumb should be that this parallel resonance frequency be at least one or two octaves (factors of one or two) above the highest audio frequency to be played back.

In the case of a practical laminated quarter-track head of one henry nominal inductance, such as the Nortronics 1200**/PB2Q2K*, the resonant frequency is approximately 50kc.

In some cases equipment designers will make use of such a relatively low resonant point to cooperate with the shielded cable from the head to boost the higher audio frequencies (20kc, for example) on playback.

MEASURING RESPONSE AND INPUT IMPEDANCE

A method of measuring playback amplifier response is shown in Figure 6-4. Here the impedance of the head will be an integral part of the circuit as it would be in actual operation. To further illustrate the importance of this technique, assume that a 1 henry playback head is being used in an amplifier that has an input impedance of only 100,000 ohms. Under these conditions the inductive reactance of the playback head at 10 kc would be about 60,000 ohms; this would produce a serious drop at the grid of the amplifier tube at this frequency.

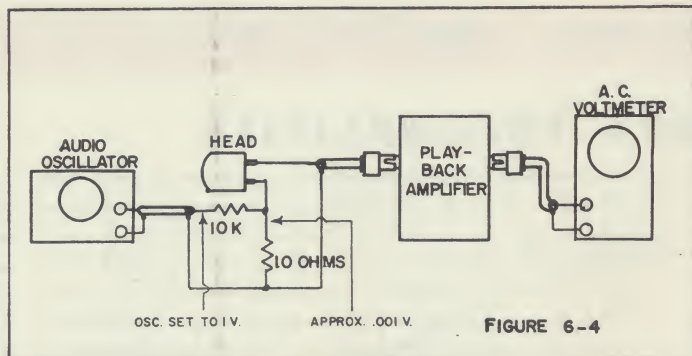


FIGURE 6-4 Method of measuring frequency response of playback pre-amplifier. The head is an integral part of the input circuit as it is in actual operation.

The output of the Nortronics 1200**/PB2Q2K* playback head is approximately 3 millivolts at 1 kc at 7.5 ips at reference recording level. (Reference recording level is approximately 12 db. below saturated tape). The 1000**/B2Q2K* combination head has an output of approximately 2.5 millivolts under the conditions stated above. When running the response of the amplifier the voltage across the 100 ohm resistor with either head should be restricted to about 1 millivolt (0.001 volts) to prevent amplifier overload at lower frequencies. This will be obvious upon examining curve 6-2 which shows that the response is up approximately 20 db. at 50 cycles referred to 1 kc. A properly designed amplifier should readily handle a 1 kc signal 15 to 20 db. above reference level with less than 5% total harmonic distortion; this will insure that amplifier distortion will not contribute to the overall tape recorder distortion at any normal operating level.

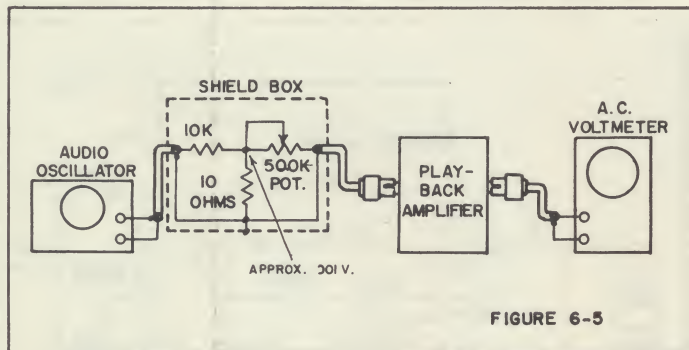


FIGURE 6-5 Method of measuring input impedance of an amplifier. A signal input of 0.001 volt is impressed and the output voltage of the amplifier noted; the potentiometer is then increased in resistance until the output voltage is halved.

Figure 6-5 shows a method of measuring input impedance. A well shielded 500 k potentiometer is inserted in series with the signal source and the amplifier. The potentiometer is first adjusted to a position of 0 resistance. A 1 kc signal of 1 millivolt is then inserted into the amplifier and the output reading is noted; the potentiometer is then adjusted until the output of the amplifier falls 6 db (one-half of its original voltage). The value of this potentiometer setting measured with an ohmmeter is the absolute value of the input impedance of the amplifier.

To obtain a complete input impedance picture, the above procedure should be duplicated at points over the entire frequency band from 20 to 20,000 cycles per second.

FILAMENT SUPPLY

The filaments of at least the first stage in a tape recording preamplifier should be energized by dc. This will greatly reduce hum pickup and correspondingly improve signal-to-noise readings. If design considerations necessitate the use of ac filament power, it would be well to use a circuit

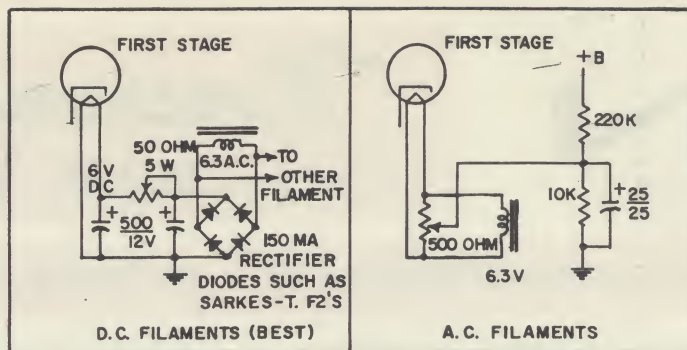


FIGURE 6-6 Methods of supplying filament power to input stage.

similar to that shown in Figure 6-6. The positive dc biasing and the corresponding hum adjust pot will provide good performance under most conditions.

PLATE POWER SUPPLY AND GROUNDING

The plate supply for a tape playback preamplifier should be well filtered and well regulated. The wiring should be carefully laid out so that ground loops will not be present in the circuit. A simplified layout schematic to accomplish this is shown in Figure 6-7. Care should be taken to avoid the use of more than one system chassis ground.

It should be pointed out here that the capacitive-resistive grid filters consisting of 47 mmf. capacitors and 1 k resistors will effectively eliminate any T.V. or F.M. rf detection at the grid of the tubes and thereby eliminate much annoying interference during tape playback.

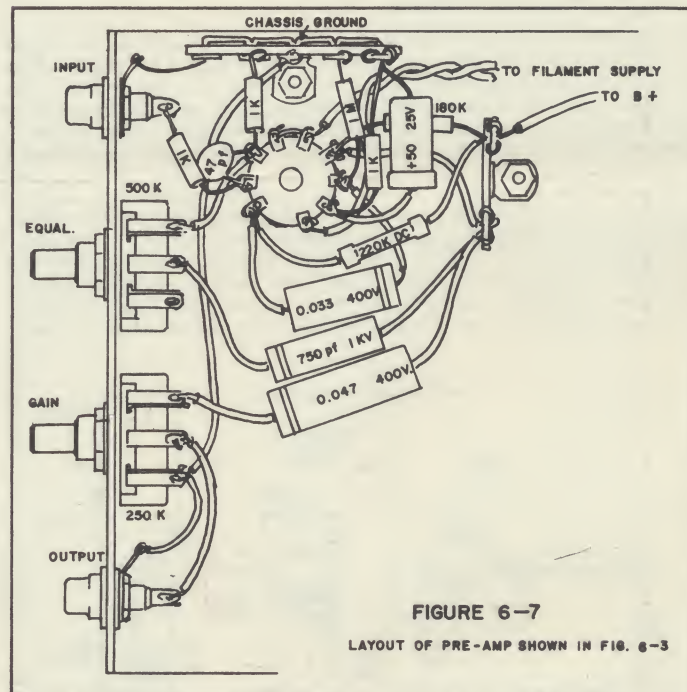


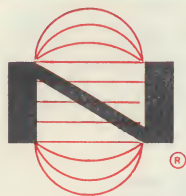
FIGURE 6-7

LAYOUT OF PRE-AMP SHOWN IN FIG. 6-3

Note to readers:

The circuits shown and described in this addendum are not necessarily free from patent design. The Nortronics Company assumes no responsibility for use in equipment design. These circuits have been tested and will provide good results in operation; this does not mean, however, that better tubes and other modifications would not provide better results under special conditions.

* Nortronics OEM Head Numbers.
** Nortronics Distributor Head Numbers



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CUSTOMER ENGINEERING BULLETIN

THE NORTRONICS COMPANY, INC. 8101 TENTH AVENUE NORTH MINNEAPOLIS, MINNESOTA 55427

TRANSISTORIZED RECORDING AMPLIFIER

GENERAL INFORMATION

The design of a magnetic recording amplifier will be discussed in the following bulletin. Since the transistor is becoming increasingly important in new equipment design it is felt that it should be treated separately from the vacuum tube.

A transistor requires no filament or heater elements and is ready to function as soon as the operating voltage is applied to the collector. As a result, objectionable line hum can generally be eliminated or reduced to very low levels. Operating voltage supplies of transistors usually run between 5 and 40 volts DC; this means that the transistorized recording amplifier can usually be designed to provide sufficient audio voltage drive without transformers to properly feed record heads with inductance readings as high as 300 millihenries.

A simplified discussion on transistor noise has been given in CEB #7. It was pointed out that three factors contributed heavily to improve noise performance. They included selection of a low voltage and current operating point, selection of low base resistance, and selection of signal frequencies to be amplified. Since the frequencies involved are necessarily in the audible range, the designer cannot make use of the fact that higher frequencies can be amplified with less associated noise.

The amplifier will primarily be for 7.5 ips tape speed with the following design points in mind:

1. The amplifier must not be adversely affected by high ambient temperatures; noise and gain characteristics must not change materially when the surrounding temperature is less than 170°F.
2. The signal-to-noise ratio must be as high as possible.
3. Equalization should produce flat final system response with Nortronics low impedance recording heads when the playback preamplifier is adjusted to the NAB type standard.
4. The input microphone impedance must permit use of a medium high impedance magnetic microphone.
5. The unit must be capable of providing audio current at least 15 db above reference recording level at 1 kc.
6. The bias oscillator must be capable of providing a bias frequency of at least 70 kc or more with low distortion.
7. Any of the above points should be changed only when amplifier expense tends to become prohibitive, or if adjustment and alignment techniques become overly complicated.

The recording amplifier must perform several functions to properly impress a magnetic recording on tape. The microphone or high level signal must be amplified, pre-equalized, and presented as a recording current signal to the head. At the same time an oscillator operating in the low supersonic range (in this case between 70 and 80 kc) provides a bias current which is electrically added—not modulated—to the audio current supplied to the head. Figure 8-1 illustrates a block schematic of the amplifier that will be described in this bulletin. This same oscillator supplies energy to erase the tape.

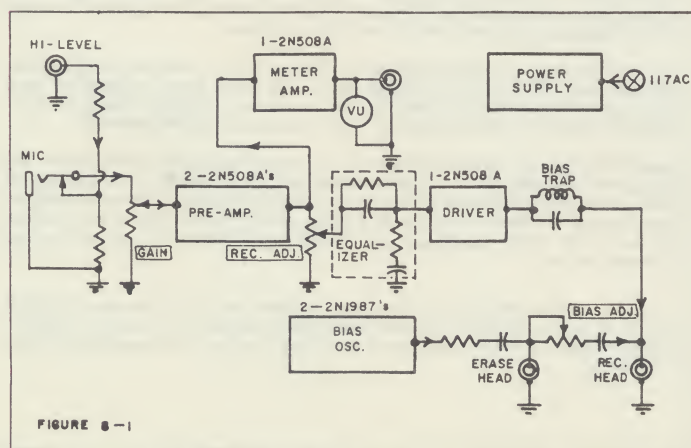


FIGURE 8-1

DESIGN CHARACTERISTICS

The operating point of the input stage is chosen so that the collector voltage is under 5 volts. This will provide a good signal-to-noise ratio under most operating conditions. The external base resistance is approximately 50,000 ohms; the parallel combination of the two biasing resistors. This provides somewhat of a compromise between the best noise performance and sufficiently high input impedance for hi-Z microphone use. The actual input impedance is, of course, a function of the feedback network.

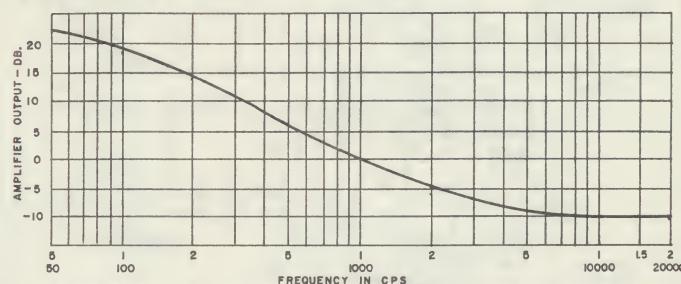


FIGURE 8-2 PLAYBACK AMPLIFIER RESPONSE WITH CONSTANT VOLTAGE INPUT INCLUDING HEAD IMPEDANCE.

The equalization for 7.5 ips is arrived at by simply extrapolating back to the NAB playback curve, the basic Nortronics constant current head response curve, and the assumption that flat system response from 50 to 20 kc is desired. The NAB playback curve is shown in Figure 8-2; this playback curve, although unofficial for 7.5 ips, is generally used by manufacturers of quality tape recorders. It represents what the output voltage of the amplifier will look like when the input is energized with a constant voltage signal in series with the playback head impedance over the audible range. CEB #6 and CEB #7 describe methods of checking playback amplifier response.

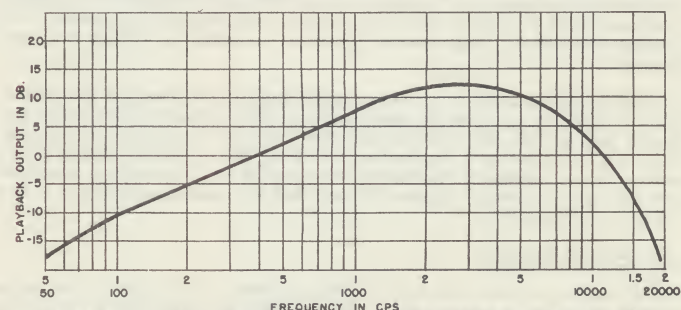


FIGURE 8-3 TYPICAL PLAYBACK HEAD RESPONSE FROM A TAPE RECORDED WITH CONSTANT CURRENT AT PEAK BIAS AT 7.5 IPS.

The curve shown in Figure 8-3 is a detailed average plot of the constant current characteristic of a typical Nortronics head such as the Model 1000 (B2Q2K). This curve would result when taking the unequaled, open circuit voltage from the terminals of a playback head that had previously been used to record the signal under conditions of constant recording current and bias current adjusted to peak 1 kc response.

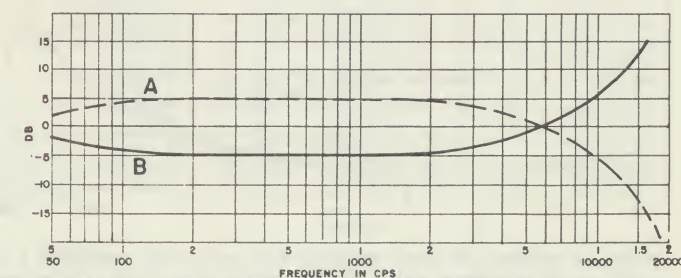
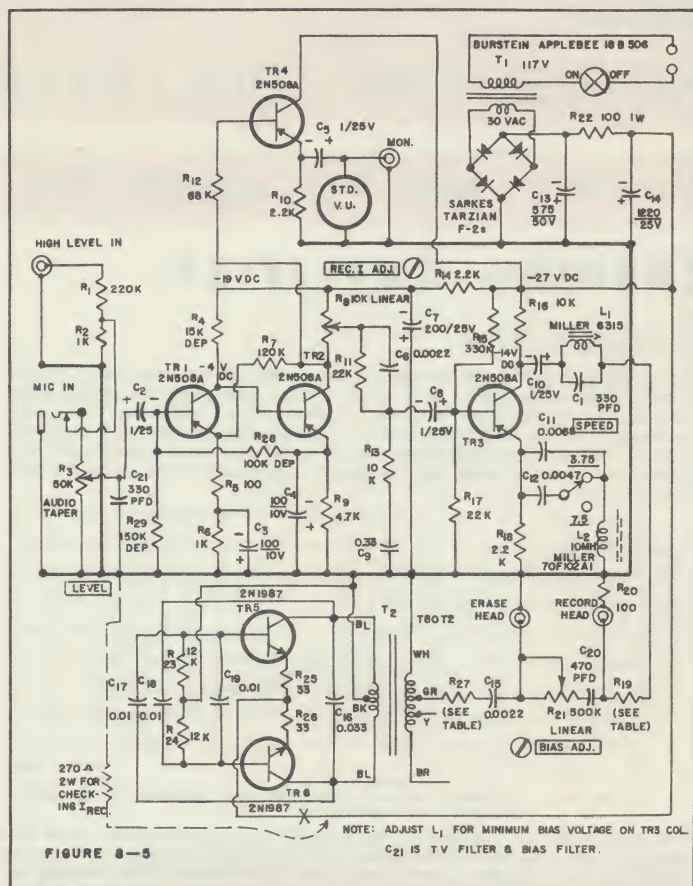


FIGURE 8-4 CURVE A RESULTS WHEN CURVE 8-3 IS SUBTRACTED FROM CURVE 8-2. B IS THE INVERSE AND REPRESENTS WHAT THE RECORD HEAD CURRENT SHOULD BE FOR FLAT SYSTEM RESPONSE.

Figure 8-2 the resultant curve is shown in Figure 8-4; it is the inverse of the curve required during the recording process to give flat, overall system response. The inverted curve which represents the desired head audio current for the amplifier designed is also shown in Figure 8-4.

The amplifier schematic is shown in Figure 8-5. The first two stages of the amplifier have a small amount of linear negative feedback included to stabilize gain, increase input impedance and generally provide amplification with low distortion between the microphone and high level inputs and the equalizer, driver stage to the head.



The equalizing components in the amplifier include R-11, C-6, R-13, C-9, C-11, C-12 and L-2. With frequencies between 200 and 1,500 cps R-11 and R-13 act as a straight voltage divider between the output of the record current adjust and the base input of the last stage. At frequencies below 200 cps the impedance (capacitive reactance) of C-9 becomes increasingly higher as the frequency goes down. This produces the slightly rising characteristic which is called for in Figure 8-4 at the low end.

At frequencies above 1,500 cps, capacitor C-6 begins to shunt resistor R-11 producing an increasing amplitude of signal at the base of the driver transistor as the frequency goes up. The series resonant action of C-11 and L-2 provides a further assist to the high end boost up to a peak of approximately 20 kc. This LC peaking circuit offers a further advantage of suppressing noise above 20 kc. The resulting curve from the high boost is shown in Figure 8-6; note that this curve is nearly the same as is called for in Figure 8-4.

THE BIAS OSCILLATOR

As previously mentioned it is necessary to add a supersonic "bias current" to the audio current during the recording process; the amplitude (or magnitude) of this current is approximately ten times the amplitude of the average audio current. If it is too high it will result in unwanted degeneration of the higher audio frequencies, and if it is too low, recording stability, distortion, and dynamic range will all be adversely affected. At the so called "peak bias" operating mode, the 1 kc signal recorded on the tape will be at its maximum value; this is a good practical point to operate a recording system. It should be noted that the curve in Figure 8-3 is a peak bias curve.

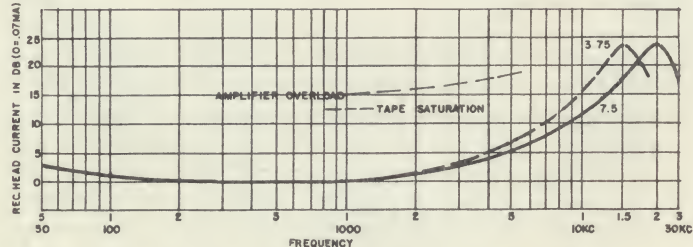


FIGURE 8-6 RECORD AMPLIFIER RESPONSE WITH HEAD 2003** (PB2H4R*). 0 db is 0 VU at 1 KC with a head current of 0.070 MA (70 Micro-amps). Note that the amplifier overload point is above the tape saturation at 1KC. With a quality playback head such as a NORTONICS 2002** (PB2H4K*) and the playback preamplifier described in CEB 7, flat system response between 50 and 15,000 cps is easily attained at 7.5 ips.

For purposes of convenience the bias oscillator generally provides the energy for the erase head during the recording process. The push-pull oscillator shown in Figure 8-5 provides low distortion energy at approximately 80 kc. R-27 and C-15 provide an erase coupling network which will properly feed a 1401** (SEQ4*), 2201** (SEH4*), or 4401** (MEF4*) Nortronics erase head. R-21 and C-20 provide a network to properly inject bias current into the record head. A bias trap consisting of L-1 and C-19 provide a buffer impedance which eases the oscillator requirement and also reduces bias intermodulation at the collector of the driver stage.

- R1 - 220k 1/2 w 10%
- R2, R6 - 1k 1/2 w 10%
- R3 - 50k pot audio taper
- R4 - 15k dep. carbon 1/8-1/2 w 5%
- R5, R20 - 100 ohm 1/2 w 10%
- R7 - 120k 1/2 w 10%
- R8 - 10k pot linear
- R9 - 4.7k 1/2 w 10%
- R10, R14, R18 - 2.2k 1/2 w 10%
- R11, R17 - 22k 1/2 w 10%
- R12 - 68k 1/2 w 10%
- R13, R16 - 10k 1/2 w 10%
- R15 - 330k 1/2 w 10%
- R19 - (see table)
- R21 - 500k pot linear
- R22 - 100 1 w 10%
- R23, R24 - 12k 1/2 w 5%
- R25, R26 - 33 ohm 1/2 w 10%
- R27 - (see table)
- R28 - 100k dep. carbon 1/8-1/2 w 5%
- R29 - 150k dep. carbon 1/8-1/2 w 5%
- C1 - 330 pfd./500 v ceramic
- C2, C5, C8, C10 - 1 mfd./25 v elect.
- C3, C4 - 100 mfd./10 v elect.
- C6, C15 - .0022 mfd./100 v paper
- C7 - 200 mfd./25 v elect.
- C9 - .33 mfd./25 v ceramic
- C11 - .0068 mfd./100 v paper
- C12 - .0047 mfd./100 v paper
- C13 - 575 mfd./50 v
MEC #BT32 575 50P
- C14 - 1200 mfd./25 v
MEC #BT32 12 25P
- C16 - .033 mfd./100 v paper
- C17, C18, C19 - .01 mfd./100 v paper
- C20 - 470 pfd./500 v ceramic
- C21 - 330 pfd./500 v ceramic
- L1 - adjustable choke 4/30 mh.
Miller 6315
- L2 - fixed choke 10 mh.
Miller 70F102A1
- T1 - Power transformer-B. A. 18B506
- 4 Silicon Rectifiers-Sarkes Tarzian F-2
- T2 - bias oscillator
T60T2
- 4 tip jacks - Switchcraft 350IFP
- TR5, TR6 - 2N1987 silicon transistors
(Minneapolis-Honeywell)
- Microphone Connector - single close
circuit (Switchcraft 12A)
- Equalization Switch, Power Switch, Etc.
standard VU meter
- TR1, TR2, TR3, TR4 - 2N508A
germanium transistors
(General Electric)

MODE	RECORD HEAD	ERASE HEAD	T2 TAP	R ₂₇	R ₁₉	I _{BIAS}	I _{REC} (KC)
HI Z-QUARTER R/P	1200** PB2Q2K*	1400** SEQ1*	BROWN	1000Ω	22kΩ	0.30 MA	0.02 MA
LO Z-QUARTER RECORD ONLY	1203** PB2Q4R*	1401** SEQ4*	GREEN	270Ω	0	0.70 MA	0.05 MA
LO Z-HALF R/P	2002** PB2H4K*	2201** SEH4*	GREEN	270Ω	0	0.80 MA	0.07 MA
LO Z-HALF RECORD ONLY	2003** PB2H4R*	2201** SEH4*	GREEN	270Ω	0	0.70 MA	0.07 MA
LO Z-FULL RECORD ONLY	4101** SLFH4R*	4401** MEF4*	GREEN	0	0	1.2 MA	0.100 MA

FIG. 8-7 DATA FOR SEVERAL NORTONICS HEADS. Measure bias current across R20 with a good electronic AC meter such as a Ballantine 310A. Measure record current by replacing the oscillator with a 270 ohm 2 watt load (see Figure 8-5).

CONSTRUCTION AND ALIGNMENT

Construction of the amplifier should follow good standard practice and excessive heat should be avoided when soldering transistors and components. The power transformer should be located away from the input transistor and if possible it should be shielded with an external steel case.

The use of the gain control before the first stage is rather unusual; it will not be a source of noise if a good quality control is used. There are several good reasons for placing the control in this position; they include: (1) The amplifier cannot be overloaded under any conditions. (2) Feedback can be applied between the first and second stage which will help to make the gain independent of transistor beta variations. The philosophy of design in this amplifier tends to promote operation at the highest signal-to-noise ratios under all conditions. The standard VU-meter which is driven by the emitter follower is, in turn, directly connected to the output of the first two stages. Therefore, when a recording is being made sufficiently high in level to give proper reading on the VU-meter (peaks from 0 to +2) the operator is making full and proper use of signal level in the first two stages.

The amplifier can be used with almost any of the currently available Nortronics record and combination record/playback heads. The table shown in Figure 8-7 gives the necessary data to adapt the amplifier for several types of heads. Using the amplifier with heads other than listed may result in depreciated performance.

Approximate bias current and reference level recording current can be pre-set from data given in Figure 8-7. Accurate determination of bias and record currents can best be achieved by using a deck with an independent playback head and amplifier. Under these conditions the bias current is adjusted until the 1 kc response is maximum and the record current is adjusted until "0-VU" on the meter is one-fourth (-12 db) of saturation level.

It must be remembered that full frequency response at 7.5 ips must be checked at least 15 db below reference recording level; this is discussed thoroughly in CEB #2. 3.75 equalization is obtained by simply switching the additional capacitor (C12) into the circuit.

* Nortronics OEM Head Numbers.

** Nortronics Distributor Head Numbers.

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CUSTOMER ENGINEERING BULLETIN

THE NORTRONICS COMPANY, INC. 8101 TENTH AVENUE NORTH MINNEAPOLIS, MINNESOTA 55427

TRANSISTORIZED RECORDING AMPLIFIER

GENERAL INFORMATION

The design of a magnetic recording amplifier using silicon transistors will be discussed in the following bulletin.

A transistor requires no filament or heater element and is ready to function as soon as the operating voltage is applied to the collector. Objectionable 60 cycle hum can generally be eliminated or reduced to very low levels. Operating voltage supplies for transistor amplifiers usually run between 5 and 40 volts DC; thus the transistorized recording amplifier can easily be designed to provide sufficient audio voltage to drive heads with inductance readings as high as 300 mhy. CEB #7 contains a simplified discussion on transistor noise. It was pointed out there that three factors contribute to the amplifier noise performance. The first stage should have a low voltage and current operating point. The base resistance should be low and the signal frequencies to be amplified are a factor. Since the frequencies involved are necessarily in the audible range, the designer must compromise with the fact that higher frequencies can be amplified with less associated noise. The amplifier described will be designed for use at 7.5, 3.75 and 1.875 ips. The design will keep the following points in mind:

1. The amplifier will not change gain characteristics when the surrounding temperature is under 190° F.
2. The signal-to-noise ratio will be as high as possible.
3. The equalization will produce flat system response with Nortronics low impedance recording heads when the playback amplifier is adjusted to NAB type standards.
4. The microphone input impedance will permit the use of a magnetic microphone of medium high impedance.
5. The unit must be capable of providing audio current at least 15 db above reference recording level at 1 kc.
6. The bias oscillator should be capable of providing a bias frequency of at least 70 kc or more with low distortion.
7. Component expense should not become prohibitive.

The recording amplifier must perform several functions to properly impress a magnetic recording on tape. The microphone or high level signal must be amplified, equalized, and presented as a recording current to the head. At the same time an oscillator operating at about 70 kc must provide a bias current which is electrically added to the audio current that is supplied to the head. Figure 9-1 illustrates a simplified schematic of the amplifier to be described. The 70 kc oscillator also supplies energy to erase the tape.

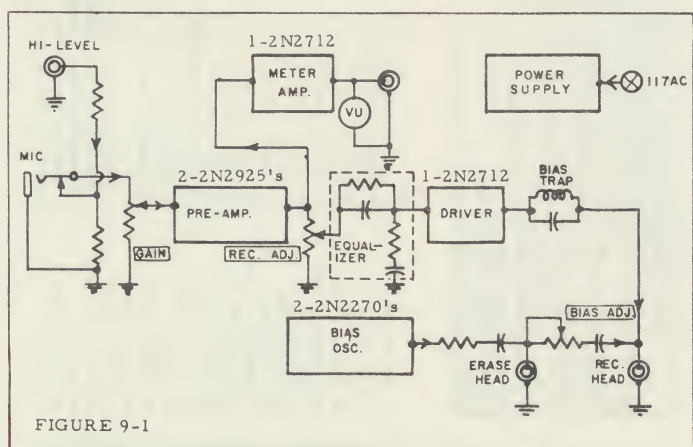


FIGURE 9-1

DESIGN CHARACTERISTICS

The operating point of the input stage is under three volts. This provides good signal-to-noise performance under most operating conditions. It is a compromise between optimum noise performance and the necessary condition of providing sufficiently high input impedance for a hi-Z magnetic microphone. The actual input impedance is, of course, a function of the feedback network used in the amplifier.

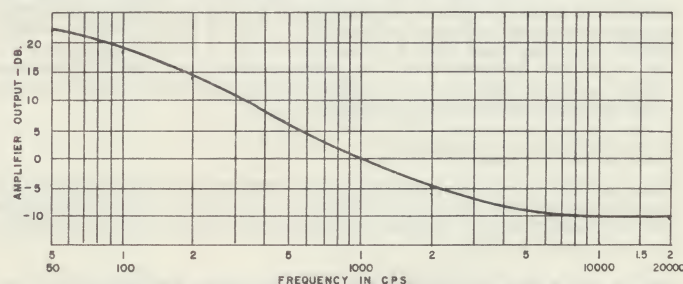


FIGURE 9-2 PLAYBACK AMPLIFIER RESPONSE WITH CONSTANT VOLTAGE INPUT INCLUDING HEAD IMPEDANCE.

The necessary equalization for 7.5 ips is arrived at by extrapolating back to the NAB playback curve, the Nortronics constant-current curve, and the assumption that flat system response is desired. To simplify the description, the curves are shown only for 7.5 ips operation. The NAB playback curve is shown in Figure 9-2; it is unofficial for 7.5 ips, but it is generally used by manufacturers of quality tape recorders. It represents what the output voltage of the amplifier will look like when the input is energized with a constant voltage signal in series with the playback head impedance over the audible range. The reader is advised to refer to CEB #6 and CEB #7 which describes methods of checking playback amplifier response.

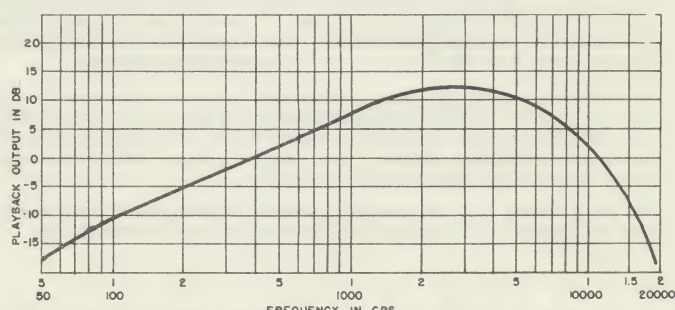


FIGURE 9-3 TYPICAL PLAYBACK HEAD RESPONSE FROM A TAPE RECORDED WITH CONSTANT CURRENT AT PEAK BIAS AT 7.5 IPS.

The curve shown in Figure 9-3 is a detailed average plot of the constant current characteristics of a typical Nortronics head such as the model 1000 (B2Q2K). This curve would result when taking the unequalized, open circuit voltage from the terminals of a head that had been previously used to record the signal under conditions of constant current recording and the bias current adjusted to a peak 1 kc response. When the curve in Figure 9-3 is subtracted from the curve shown in Figure 9-2, a resultant curve is shown in Figure 9-4; the inverse of this curve represents the desired audio head current to give overall flat system response.

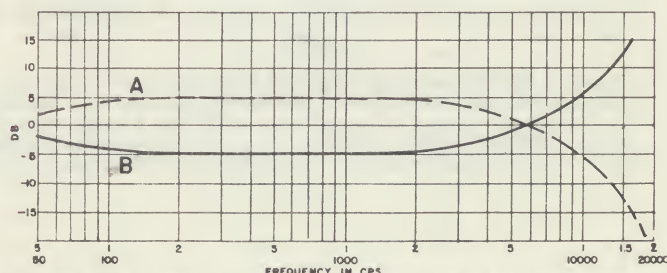


FIGURE 9-4 CURVE A RESULTS WHEN CURVE 9-3 IS SUBTRACTED FROM CURVE 9-2. B IS THE INVERSE AND REPRESENTS WHAT THE HEAD CURRENT SHOULD BE FOR FLAT SYSTEM RESPONSE.

The amplifier schematic is shown in Figure 9-5. The first two stages of the amplifier have a small amount of linear negative feedback to stabilize gain, increase input impedance and generally provide amplification with low distortion between the microphone or high level input and the equalizer driver stage to the head.

The equalizing components in the amplifier include R11, C6, R13, C9, L2 and C11. At frequencies between 200 and 1500 cps R11 and R13 act as a straight voltage divider between the output of the linear amplifier and the input to the driver stage. At frequencies below 200 cps the impedance (capacitive reactance) of C9 becomes increasingly higher as the frequency goes down. This produces the slightly rising characteristic that is called for in Figure 9-4 at the low end.

At frequencies above 1500 cps capacitor C6 begins to shunt resistor R11 producing an increasing amplitude of signal at the input of the driver transistor as the frequency goes up. The series resonant action of L2 and C11 provides a further assist to the high end boost up to a peak of approximately 20 kc. This LC peaking circuit tends to suppress noise above 20 kc. The resulting curve from the high boost is shown in Figure 9-6; note that this curve is nearly the same as is called for in Figure 9-4.

THE BIAS OSCILLATOR

As previously mentioned, it is necessary to add a supersonic "bias current" to the audio current during the recording process; the amplitude (or magnitude) of this current is approximately ten times the amplitude of the average audio current. If it is too high it will result in unwanted degeneration of the higher audio frequencies, and if it is too low, recording stability, distortion, and dynamic range will all be adversely affected. At the so called "peak bias" operating mode the 1 kc signal recorded on the tape will be at its maximum level; this is a good practical point to operate a recording system. It should be noted that the curve in Figure 9-3 is a peak bias curve.

For purposes of convenience the bias oscillator generally provides the energy for the erase head during the recording process. The push-pull oscillator shown in Figure 9-5 provides low distortion energy at approximately 80 kc. R-27 and C-15 provide an erase coupling network which will properly feed a 1401** (SEQ4*), 2201** (SEH4*), or 4401** (MEF4*) Nortronics erase head. R-21 and C-20 provide a network to properly inject bias current into the record head. A bias trap consisting of L-1 and C-19 provide a buffer impedance which eases the oscillator requirement and also reduces bias intermodulation at the collector of the driver stage.

CONSTRUCTION AND ALIGNMENT

Construction of the amplifier should follow good standard practice and excessive heat should be avoided when soldering transistors and components. The power transformer should be located away from the input transistor, and if possible it should be shielded with an external steel case.

The use of the gain control before the first stage is rather unusual; it will not be a source of noise if a good quality control is used. There are several good reasons for placing the control in this position; they include: (1) The amplifier cannot be overloaded under any condition. (2) Feedback can be applied between the first and second stage which will help to make the gain independent of transistor beta variations. The philosophy of design in this amplifier tends to promote operation at the highest signal-to-noise ratios under all conditions. The standard VU meter which is driven by the emitter follower is, in turn, directly connected to the output of the first two stages. Therefore, when a recording is being made sufficiently high in level to give proper reading on the VU meter (peaks from 0 to +2), the operator is making full and proper use of signal level in the first two stages.

The amplifier can be used with almost any of the currently available Nortronics record and combination record/playback heads. The table shown in Figure 9-7 gives the necessary data to adapt the amplifier for several types of heads. Using the amplifier with heads other than listed may result in depreciated performance.

Accurate bias current and reference level recording current can be pre-set from data given in Figure 9-7. A more accurate determination of bias current can be achieved by adjusting the bias until a given 1 kc record level (well below saturation) produces the highest reading during playback. 1 kc playback voltage is below this maximum point when the bias current is too low or too high.

The record current level can best be determined by making use of a test tape such as the new Nortronics AT-100 that has a pre-recorded tone at reference level.

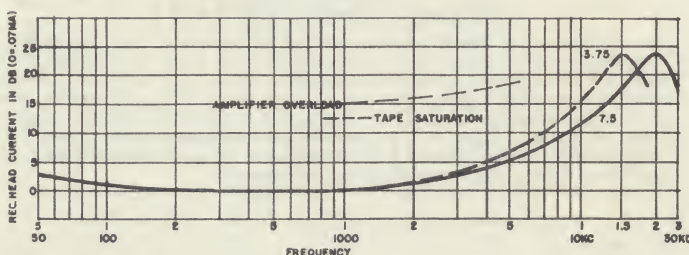


FIGURE 9-6 RECORD AMPLIFIER RESPONSE WITH HEAD 2003** (PB2H4R*). 0 db is 0 VU at 1 KC with a head current of 0.070 MA (70 Micro-amps). Note that the amplifier overload point is above the tape saturation at 1KC. With a quality playback head such as a NORTONICS 2002** (PB2H4K*) and the playback preamplifier described in CEB 7, flat system response between 50 and 15,000 cps is easily attained at 7.5 ips.

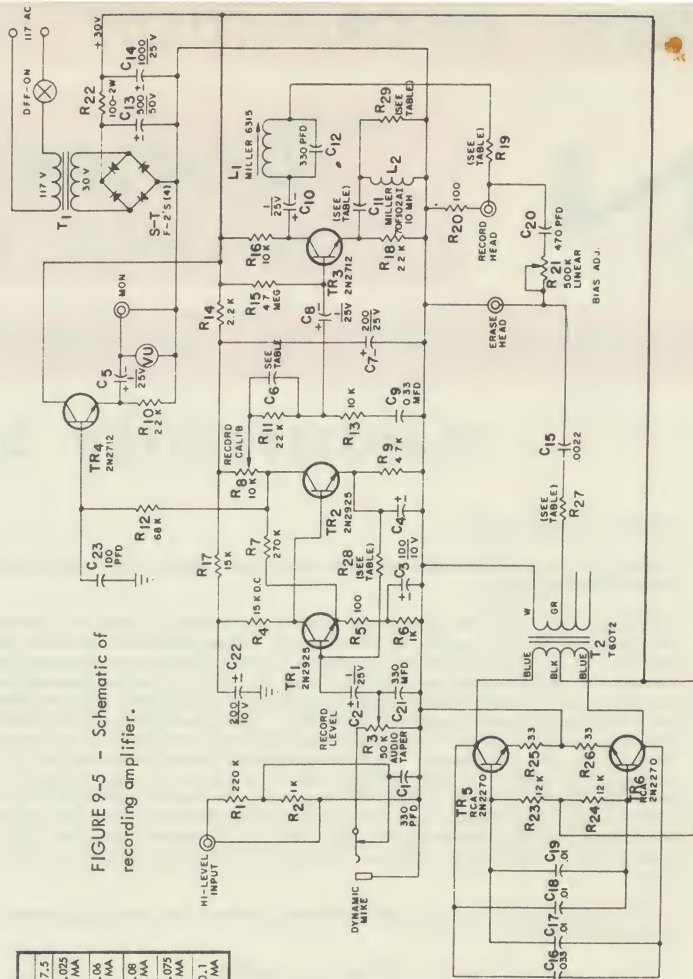


FIGURE 9-5 - Schematic of recording amplifier.

RECORD	MODE	BIAS	T2	K27	R19	C6	C11	R29	BIAS	I RECORD
HEAD	TAP	1.875	3.75	7.5	1.875	3.75	7.5	1.875	3.75	7.5
SEQ1	Brown	1K	1K	4.7K	4.7K	.002	.015	.006	2.7K	1.8K
1201										
SEQ4	Green	270K	270K	0	0	.002	.015	.006	2.7K	1.8K
1301										
P-8204K	Green	270K	270K	0	0	.002	.015	.006	2.7K	1.8K
1401										
P-8204R	Green	270K	270K	0	0	.002	.015	.006	2.7K	1.8K
2001										
SEF4	Green	270K	270K	0	0	.002	.015	.006	2.7K	1.8K
2201										
P-8204R	Green	270K	270K	0	0	.002	.015	.006	2.7K	1.8K
2301										
SEF4R	Green	270K	270K	0	0	.002	.015	.006	2.7K	1.8K
2401										
MEF4	Green	0	0	0	0	.002	.015	.006	2.7K	1.8K
4101										

SPECIAL NOTES:

R28 should be adjusted so that so that voltage on collector of TR2 is equal to one-half of the voltage at junction of R17, R14 and Rg

L1 should be adjusted so that 80 kc bias voltage on collector of R16 is a minimum.

Be sure to use head sinks on TR5 and TR6.

- C1, C11, C12, C21 - 330 pfd. 500 v. ceramic
- C2, C5, C8, C10 - 1 mfd. 25 v. elect.
- C3, C4 - 100 mfd. 10 v. elect.
- C6 - see table
- C7 - 200 mfd. 25 v. elect.
- C9 - 0.33 mfd. 25 v. ceramic
- C11 - see table
- C13 - 500 mfd. 50 v. elect.
- C14 - 1000 mfd. 25 v. elect.
- C15 - .002 mfd. 200 v. paper
- C16 - .003 mfd. 100 v. paper
- C17, C18, C19 - .01 mfd. 100 v. paper
- C20 - 470 pfd. 500 v. ceramic
- C22 - 200 mfd. 10 v. elect.
- C23 - 100 pfd. 500 v. ceramic
- L1 - adjustable choke 430 mhy. Miller 6315
- L2 - fixed choke 10 mhy. Miller 70F102A1
- T1 - power transformer Burman Appliance 18B506
- Silicon Rectifiers - Sinter-Terion F-2
- T2 - Nortronics oscillator coil 16012
- R1 - 200K 1/2 W = 10%
- R2, R6 - 1K 1/2 W = 10%
- R3 - 50K pot audio taper
- R4 - 15K OC 1/4-1/2 W = 5%
- R5, R20 - 100 ohms 1/2 W = 10%
- R7 - 10K pot linear taper
- R8 - 10K pot linear taper
- R9 - 4.7K 1/2 W = 10%
- R10, R14, R18 - 2.2K 1/2 W = 10%
- R11 - 22K 1/2 W = 10%
- R12 - 68K 1/2 W = 10%
- R13, R16 - 10K 1/2 W = 10%
- R15 - 4.7M 1/2 W = 10%
- R19 - see table
- R21 - 500K pot linear taper
- R22 - 100 ohms 1 W = 10%
- R23, R24 - 12K 1/2 W = 10%
- R25, R26 - 33 ohms 1/2 W = 10%
- R27 - see table
- R28 - see note below table
- R29 - see table
- R29 - see table

- * Nortronics OEM Head Numbers.
- ** Nortronics Distributor Head Numbers.



Nortronics®

CUSTOMER ENGINEERING BULLETIN

THE NORTRONICS COMPANY, INC. 8101 TENTH AVENUE NORTH MINNEAPOLIS, MINNESOTA 55427

TRANSISTORIZED PLAYBACK PREAMPLIFIER

GENERAL INFORMATION

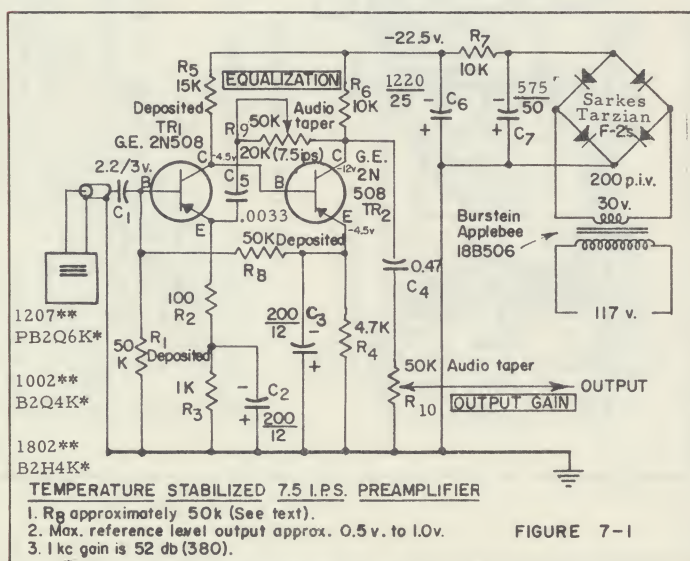
Although the vacuum tube is widely used in tape recording amplification, the transistor is becoming more important in new equipment design. In inexpensive home machines current transistor prices now permit recorder manufacturers to compete with tubes especially when filament supplies, tube sockets, etc. are eliminated.

The following bulletin will discuss the design of an NAB type equalized, transistorized preamplifier for playback use at 7.5 ips. The following points will form the basis for the design:

- (1). The preamplifier must not be adversely affected by high ambient temperatures; in other words, noise characteristics must not change materially when the surrounding temperature is less than 180°F.
- (2). The signal-to-noise ratio must be as high as possible. This will be discussed for application with Nortronics low impedance heads.
- (3). Equalization should permit flat system response with a tape pre-recorded to NAB or similar standards.
- (4). Feedback equalization should be used to raise input impedance and reduce gain variations due to transistor differences. This is especially important if more than one preamp is constructed.
- (5). This unit must be capable of handling input levels with low distortion at least 15 db above reference recording level.
- (6). Any of the above points should be compromised only if it is necessary to make the amplifier less expensive.

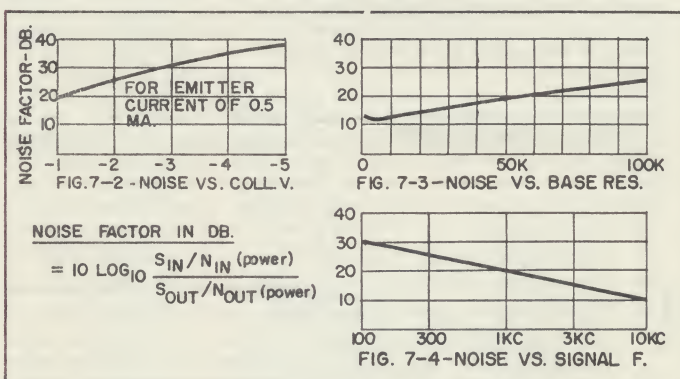
DESIGN CHARACTERISTICS

The circuit is stabilized to prevent variations of performance with high operating temperature. This is accomplished by several techniques including d.c. negative feedback from the emitter of the second stage to the base of the first stage; direct coupling from the first stage collector to the second stage base is an integral part of the stabilization technique. Both stages are further stabilized by having relatively large bypassed emitter resistors.



Obtaining a good signal-to-noise ratio involves a number of considerations which will be discussed very briefly. First it must be remembered that three factors contribute heavily to noise performance. These include the operating point (current and voltage) of the base and collector, the base resistance and the signal frequencies involved.

The operating point (see Figure 7-2) should be chosen to use low collector voltage. Here a compromise has been made; the collector voltage on the first stage is -4.5 volts which is necessary because the supply voltage of -22.5 volts establishes the collector voltage on the second stage (-12 volts) which in turn requires between -4 and -4.5 volts for proper bias on the base. This relatively high supply and collector voltage is necessary to retain large signal handling capacity with a head (such as the half track 1801**/B2H7K*) that has a reference level of .0012 volts and above at 1 kc at 7.5 ips. For heads having a nominal output below .0012 volts at reference level it might be desirable to reduce the supply voltage to as low as -12 volts. This will sharply reduce noise output without sacrificing amplifier gain and still give 15 db overload factor.



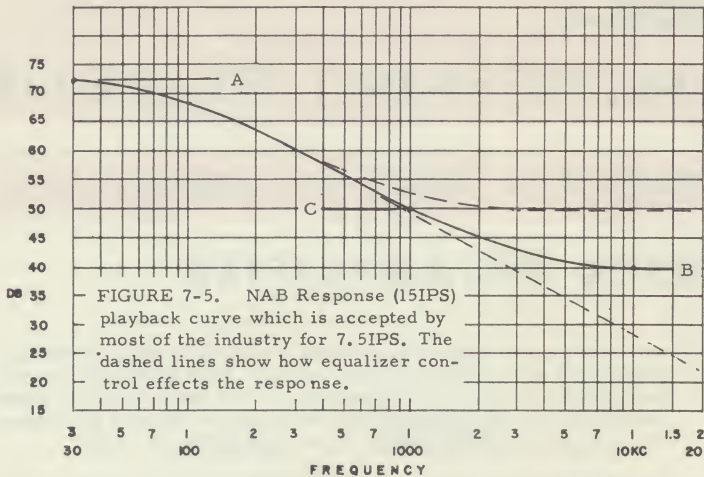
The base resistance is the parallel combination of the biasing resistors, and is approximately 20 to 25k. Referring to Figure 7-3 it will be seen that this again is a compromise from the optimum position. This is because the base resistance must be kept high enough to avoid degeneration of frequencies in the high audio frequency band. This will be discussed in detail later.

Unfortunately the noise factor rises with decreasing frequencies as shown in Figure 7-4. This shows that with frequencies below 10 kc the associated noise goes up approximately 10 db per decade decrease in frequency. This, of course, is an unavoidable problem and would be common to any transistor amplifier used in the audio band.

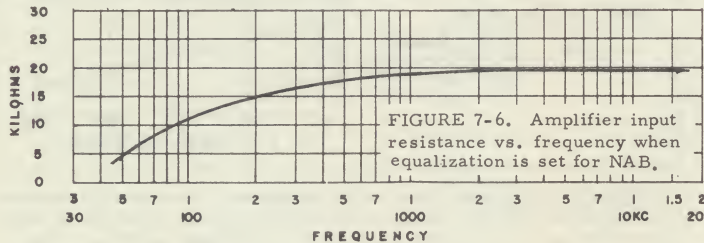
Determining the proper equalization to obtain the NAB type response curve as shown in Figure 7-5 will require some knowledge of head operation with a transistor amplifier. The transistor requires a discreet amount of input power; the magnetic head must actually furnish active power (current and voltage) during the playback process. This contrasts with the conventional vacuum tube preamplifier that usually has an input impedance well above 250k and requires only a voltage signal. The design tendency in professional vacuum tube preamplifiers, therefore, is to use a very high inductance playback head to enhance signal-to-noise ratio. Under these conditions the output of the head is limited only when the number of turns of the playback head and the corresponding self-inductance become so great that the self-parallel resonant frequency becomes low enough to adversely affect high audio frequency performance (see CEB #6).

In the transistor preamplifier the head impedance--which consists of the effective resistance of the head as well as the inductive reactance component--should be low enough over the entire audio band to provide negligible attenuation of high frequencies and yet high enough to take

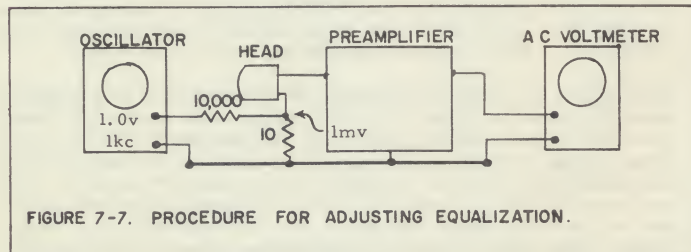
advantage of good power transfer to the transistor base. Practically speaking heads such as the Nortronics 1002**/B2Q4K*, 1207**/PB2Q6K* or 1802**/B2H4K* which have inductance of less than 200 millihenries will provide optimum performance for the amplifier shown in Fig. 7-1. A curve of amplifier input Z vs. frequency is shown in Fig. 7-6.



A simple method of determining the base resistor R_B and the feedback network will now be discussed: Omit the feedback network consisting of R_9 and C_5 and energize the circuit as shown in Figure 7-7. The head is included in the circuit to compensate for losses in power transfer from the head to the amplifier; the 0.001 volt signal across the 10 ohm resistor simulates the voltage generated by the head under actual playback. With this 1 kc signal fed into the amplifier as described, resistor R_B is adjusted until a maximum output is obtained on the collector of the second stage as observed by a high impedance a.c. voltmeter or oscilloscope. Under these conditions the output will be about 4.5 volts or a voltage gain of approximately 72 db. Next a temporary feedback network consisting of a large capacitor (about 0.1 mfd.) and a 100k potentiometer is inserted between the second stage collector and the first stage emitter (temporary R_9 and C_5). The potentiometer is then gradually decreased in resistance until the 1 kc output decreases to a point 32 db below the maximum output point (about 1/40) in voltage ratio. These points are represented by A and B respectively in Figure 7-5. Retaining the potentiometer setting, the 0.1 mfd. capacitor is now experimentally reduced until the 1 kc response rises to 22 db (approximately 1/13) below the open loop gain. This is represented by C in Figure 7-5. The center value of the network C_5 and R_9 as determined in this manner is 0.0033 mfd. and 20k. A 50k potentiometer is



shown in the schematic; this can be adjusted above or below to achieve equalization differences to compensate for different tape speeds and small head differences. A further check on overall adjustments can be achieved under conditions of actual operation by using a commercial alignment tape such as the Nortronics AT-100.



As previously discussed the amplifier must be capable of handling input signals 15 db in voltage ratio above reference level. The Nortronics reference level is -12 db below tape saturation at 1 kc. This is not necessarily an accepted figure in the industry, but it is very close to a 2% total harmonic distortion point which is in turn centered within the industry.

- * Nortronics OEM Head Numbers.
- ** Nortronics Distributor Head Numbers.

CONSTRUCTION HINTS

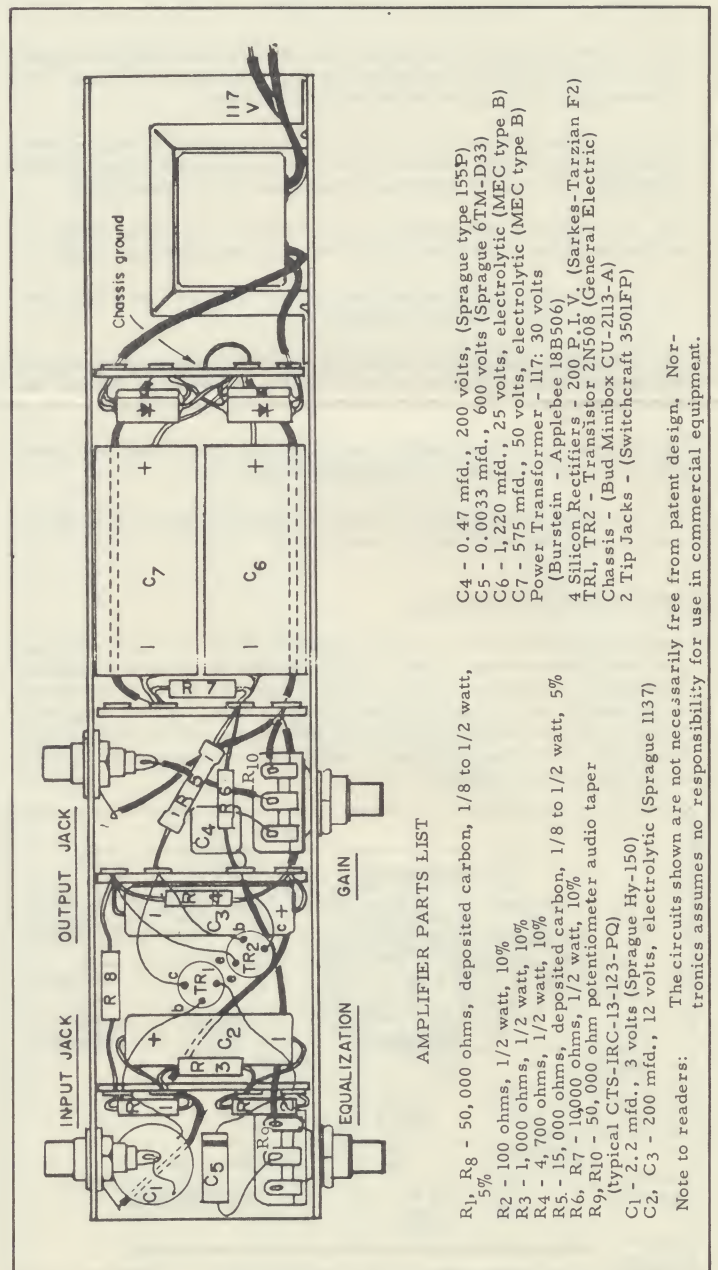
The amplifier just described will provide good performance at either 7.5 or 15 ips tape speeds. The only industry standard is the NAB type 15 ips curve as shown in Figure 7-5; fortunately the industry has generally accepted this same general curve for most 7.5 ips work. At 3.75 and 1.875 ips the potentiometer must be increased to provide the desired system response; appropriate information for doing this is discussed in CEB #2.

General amplifier performance is summarized in Figure 7-8.

HEAD TYPE	INDUCT MH.	1KC REF. LEVEL HEAD OUT.	AMPLIFIER DC SUPPLY VOLTAGE	AMPLIFIER NOISE OUTPUT	1KC REF. LEVEL AMPL. OUT.	AMPLIFIER GAIN 1 KC	REF. LEVEL SIGNAL TO NOISE RATIO
B2Q4K* 1002** Quarter	100	0.75mv	-12v	1.4mv	0.3v	52db	47db
PB2Q6K* 1207** Quarter	200	1.1	-12	1.4	0.45	52	50
B2H4K* 1802** Half	100	1.0	-12	1.4	0.42	52	49
B2H7K* 1801** Half	350	2.0	-22.5	2.5	0.83	53	51
SLF4L* Full	100	2.5	-22.5	2.5	1.00	53	52

① THIS HEAD HAS A HIGH ENOUGH INDUCTANCE TO DEPRECIATE HIGH FREQUENCY AUDIO PERFORMANCE WITH THIS AMPLIFIER.

FIGURE 7-8. SUMMARY TABLE OF AMPLIFIER PERFORMANCE.





Nortronics® Record, Playback, Record/Play, Erase & Combo Heads

THE NORTRONICS COMPANY, INC. 8101 TENTH AVENUE NORTH MINNEAPOLIS, MINNESOTA 55427

DESCRIPTION.

NORTRONICS magnetic tape heads are designed to offer highest quality performance and long dependable service. As the chief exponent and largest manufacturer of laminated core heads, NORTRONICS now offers a completely new line, with heads available in either PREMIUM or STANDARD laminated versions. NORTRONICS is also including the new "COMBO" heads which combine Record/Play/Erase into one head.

The STANDARD versions offer improved high frequency performance over that of the conventional solid-core heads, plus the added features of hyperbolic all-metal face and precision deposited quartz gaps.

The PREMIUM series is a fully professional line of tape heads giving unsurpassed performance for broadcast, studio and exacting semi-professional applications. Long life and extended high frequency response at slower tape speeds are among the benefits of the features listed below:

- Fine laminated, precision-lapped, low loss core structures.
- Deposited quartz gaps, resulting in exceptionally clean sharp gap edges.
- Hyperbolic face contour gives intimate tape-to-gap contact without need for pressure pads, but is designed to allow use with pressure pads as well.
- Highly polished all-metal faces, greatly reduce oxide build-up and the need for frequent head cleaning.
- Compatible mechanically and electrically with older model NORTRONICS heads.
- Superbly shielded against external magnetic fields.

The "Combo" series heads combine all of the features of the Premium series above, except the hyperbolic face contour. This series has a Record/Play Head and an Erase Head in one case.

MOUNTING STYLES.

The wide variety of available mounting styles, track types and impedances make it possible to find a NORTRONICS head to suit almost any audio application. Your new NORTRONICS head is supplied in two basic mounting styles, NO MOUNT and REAR MOUNT. REAR MOUNT heads have a rear mounting stud with 12-inch shielded wires. NO MOUNT heads have no brackets, screws or wires attached to them and are used directly in several popular brands of tape recorders. When required, NO MOUNT heads may be quickly adapted to SIDE MOUNT and BASE MOUNT styles by using the proper NORTRONICS Quik-Kit which is available where you purchased your NORTRONICS tape head. Complete, detailed instructions are included with each Quik-Kit. The six basic Quik-Kits used for adapting NO MOUNT heads are:

- | | |
|-------|---|
| QK-18 | Adapts all standard No Mount Erase Heads to Side Mount. |
| QK-19 | Adapts all standard No Mount Erase Heads to Base Mount. |
| QK-20 | Adapts 3000 thru 3049, 3100 thru 3149, and 3200 thru 3249 No Mount R/P Heads and Record Only Heads to Side Mount. |
| QK-21 | Adapts 3000 thru 3049, 3100 thru 3149, and 3200 thru 3249 No Mount R/P Heads and Record Only Heads to Base Mount. |
| QK-38 | Adapts all other No Mount R/P Heads, Record Only Heads, and Combo Heads to Side Mount. |
| QK-66 | Adapts all other No Mount R/P Heads, Record Only Heads, and Combo Heads to Base Mount. |

REPLACEMENT OR CONVERSION.

NORTRONICS heads are the ideal selection for replacement of existing heads, converting to 2 or 4-track stereophonic sound and for installation on new tape equipment. In the majority of cases, replacements will be made on a direct basis. For exam-

ple, a 2-track stereo head will be used to replace a worn 2-track stereo head. It is often possible to interchange head types to modernize equipment or for special applications. An example of this would be substituting a 4-track stereo head for a 2-track stereo head to bring the recorder up to date, or substituting a Full track monophonic head for a 2-track monophonic head to make a recorder suitable for broadcast purposes. In such interchanges, it is important to bear in mind that mechanical and electrical compatibility is required between head types to avoid operating difficulties.

LAMINATED vs. SOLID CORE HEADS.

Heads for magnetic tape recorders are generally manufactured with either laminated or solid metal cores. Excellent heads can be made in either type and NORTRONICS produces both but specializes in laminated heads because the unexcelled quality and superior performance of this type head is demanded in ever increasing numbers by knowledgeable audiophiles, serious tape enthusiasts, and original equipment manufacturers for use in their best recorders. The NORTRONICS heads featuring professional type laminated core structures with ultra-fine gaps result in magnificent playback frequency response. At a tape speed of 7.5 ips, a flat response from 50 to 15,000 cps is readily attainable, with useful output down to 30 cps and up to 20,000 cps. At a speed of 3.75 ips, the response is flat from 50 to 10,000 cps with useful output down to 30 cps and up to 15,000 cps.

Laminated heads are more expensive to construct because permissible tolerances are considerably tighter, materials used are costlier and rigid tests must be made at each production level. The grinding, lapping and polishing operations require a high degree of skill and equipment of specialized design. After the head is completely finished, it must go through a further series of final checks and tests before it is approved for release. Any head which fails to pass through the stringent checks of Final Testing is automatically rejected. The end result is a laminated head of superior design . . . a superlative product of such exacting quality, it is literally capable of bringing out the best possible performance of any tape recorder with which it is used.

Laminated heads have clearly demonstrable advantages over solid core types which more than justify the extra care and expense required to manufacture them. As stated before, excellent heads can be made in either type and NORTRONICS produces BOTH. The major advantages of laminated design are lower eddy current and hysteresis losses in the core at high audio frequencies during playback. Drop-off in high frequencies is actually due to both the gap effect and core losses. As a result of the reduced core losses in laminated heads, the output at high frequencies is correspondingly greater than that obtained from an equivalent solid core head with the same size gap. Consequently, with the tape speeds in current popular use (7.5 and 3.75 ips), laminated heads can use a wider gap for improved recording characteristics while attaining essentially the same playback frequency response as solid core heads. In addition, because of the improved efficiency and sensitivity of laminated heads, a greater depth of metal can be left on the pole faces of the head. This insures longer operating life before wear makes replacement necessary. Despite anything you might have heard to the contrary, TAPE HEADS DO WEAR OUT!

At the present stage of the tape recording art, the finest heads available are of laminated design. NORTRONICS is continuously engaged in an extensive research program covering a wide area of interest to constantly improve the performance and quality of its products while still maintaining a sensible price structure. Several design concepts utilizing a new approach to materials not presently being used in the production of magnetic tape heads are currently undergoing evaluation. These materials require novel processing techniques and some of them hold great promise for the future. You may be sure that when any improvements either in head design or the materials used in those designs are ready to be moved from Research to Production, NORTRONICS will produce them.

TAPE HEAD SPECIFICATIONS

Record/Play and Record Only Heads

See next page for dimensions.



1000 THRU 1049
1200 THRU 1249



1050 THRU 1099
1250 THRU 1299



1800 THRU 1849
2000 THRU 2049



1850 THRU 1899
2050 THRU 2099



2600 THRU 2649



3000 THRU 3049
3200 THRU 3249



3050 THRU 3099
3250 THRU 3299



3100 THRU 3149



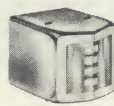
4100 THRU 4149



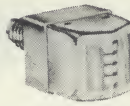
4150 THRU 4199



4950 THRU 4999



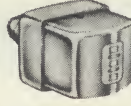
5600 THRU 5649



5650 THRU 5699



5700 THRU 5749



5750 THRU 5799

NEW
HYPERBOLIC
FACE



AVAILABLE ON ALL R/P
HEADS. GIVES IMPROVED
TAPE TO GAP CONTACT
ON RECORDERS NOT RE-
QUIRING PRESSURE PADS.

NORTRONICS MODEL NO.		HEAD DESCRIPTION	HEAD FUNCTION	APPLICATION (See Notes)	1 KC INDUCTANCE		1 KC IMPEDANCE		MAXIMUM BIAS FREQUENCY		DC RESISTANCE		GAP SPACER		TRACK WIDTH		TRACK SPACING Center-to-Center		1 KC CROSSTALK REJECTION		Average 7.5 IPS constant-current R/P characteristics, using 3M190 Tape, peak biased at 1 kc and recorded 12 db below tape saturation.					
NO MOUNT	REAR MOUNT				MHY	OHMS	KC	OHMS	MILS	INCH	INCH	DB	60 KC PEAK BIAS	BIAS VOLTAGE RMS 60KC	RECORD CURRENT	1 KC OUTPUT	10 KC/1 KC RATIO									
																		MA	VOLT	UA	M A	DB				
1000	1050	STANDARD 4-TRACK STEREO Hyperbolic Metal Face Laminated Cores	Record/Play	1	800	5000	80	700	0.1	.043	.136	55	0.30	45	25	2.4	-3									
1001	1051		Record/Play	3	400	2500	100	390	0.1	.043	.136	55	0.42	35	35	1.6	-3									
1002	1052		Record/Play	6	100	650	140	90	0.1	.043	.136	55	1.1	20	70	0.8	-4									
1008	-		Record/Play	6	110	700	100	210	0.2	.043	.136	55	0.5	12	50	1.2	-3									
1009	-		Record/Play	3	500	3300	100	700	0.2	.043	.136	55	0.15	25	23	3.0	-3									
1200	1250	PREMIUM 4-TRACK STEREO Hyperbolic Metal Face Laminated Cores	Record/Play	1	800	5000	80	700	0.1	.043	.136	55	0.16	45	25	2.6	+1									
1201	1251		Record/Play	3	400	2500	100	390	0.1	.043	.136	55	0.25	35	35	1.8	+1									
1202	1252		Record/Play	6	100	650	140	90	0.1	.043	.136	55	0.70	18	70	0.9	0									
1203	1253		Record Only	8	50	400	250	90	0.5	.043	.136	55	0.65	7.5	60	-	-									
1205	1255		Record Only	4	200	1300	120	390	0.5	.043	.136	55	0.26	20	38	-	-									
1207	1257		Record/Play	5	200	1300	120	200	0.1	.043	.136	55	0.40	25	50	1.3	+1									
1210	-		Record Only	7	10	70	500	32	0.5	.043	.136	55	1.3	3.0	140	-	-									
1221	-		Play Only	3	500	3300	100	390	0.05	.043	.136	55	0.25	50	-	1.8	2									
1800	1850	STANDARD 2-TRACK STEREO Hyperbolic Metal Face Laminated Cores	Record/Play	1	800	5000	60	720	0.1	.080	.160	55	0.4	65	30	3.4	-3									
1801	1851		Record/Play	3	400	2500	100	410	0.1	.080	.160	55	0.6	45	40	2.2	-3									
1802	1852		Record/Play	6	100	650	150	130	0.1	.080	.160	55	1.1	20	80	1.1	-4									
2000	2050	PREMIUM 2-TRACK STEREO Hyperbolic Metal Face Laminated Cores	Record/Play	1	800	5000	60	720	0.1	.080	.160	55	0.25	55	30	3.6	-1									
2001	2051		Record/Play	3	400	2500	100	410	0.1	.080	.160	55	0.33	40	40	2.4	+1									
2002	2052		Record/Play	6	100	650	150	130	0.1	.080	.160	55	0.80	20	80	1.2	0									
2003	2053		Record Only	8	50	320	200	130	0.5	.080	.160	55	0.70	9	75	-	-									
2007	2057		Record/Play	5	200	1300	100	245	0.1	.080	.160	55	0.40	30	60	1.8	+1									
2010	-		Record Only	7	10	72	500	27	0.5	.080	.160	55	1.7	3.3	200	-	-									
2021	-		Play Only	2	450	3300	80	410	0.05	.080	.160	55	0.46	55	-	2.2	+2									
2047	-		R/P Dual Impedance	6 3	100 400	650 2500	150 100	130 410	0.1 0.1	.080 .080	.160 .160	55 55	0.80 0.33	20 40	80 40	1.2 2.4	0 +1									
2600	-	PREMIUM 2-TRACK MONO Hyperbolic Metal Face Laminated Cores Track .040 Off Center	Record/Play	1	800	5000	60	400	0.1	.080	-	-	0.25	55	30	3.6	+1									
2601	-		Record/Play	3	400	2500	100	165	0.1	.080	-	-	0.33	40	40	2.4	+1									
2602	-		Record/Play	6	100	650	150	70	0.1	.080	-	-	0.80	20	80	1.2	0									
2603	-		Record Only	8	50	320	200	70	0.5	.080	-	-	0.70	9	75	-	-									
2630	-		Record Only	7	10	70	500	14	0.5	.080	-	-	1.7	3.3	200	-	-									
3000	3050	STANDARD 2-TRACK MONO Hyperbolic Metal Face Laminated Cores	Record/Play	1	800	5000	60	400	0.1	.080	-	-	0.4	65	30	3.4	-3									
3001	3051		Record/Play	3	400	2500	100	165	0.1	.080	-	-	0.6	45	40	2.2	-3									
3002	3052		Record/Play	6	100	650	150	70	0.1	.080	-	-	1.1	20	80	1.1	-4									
3100	-	2-TRACK MONO (Center Track) Cylindrical Metal Face Solid Cores	Record/Play	1	1000	6300	60	625	0.16	.090	-	-	0.65	60	22	5.0	-9									
3101	3151		Record/Play	3	400	2500	80	350	0.16	.090	-	-	0.8	25	30	3.0	-9									
3200	3250	PREMIUM 2-TRACK MONO Hyperbolic Metal Face Laminated Cores	Record/Play	1	800	5000	60	400	0.1	.080	-	-	0.25	55	30	3.6	+1									
3201	3251		Record/Play	3	400	2500	100	165	0.1	.080	-	-	0.33	40	40	2.4	+1									
3202	3252		Record/Play	6	100	650	150	70	0.1	.080	-	-	0.80	20	80	1.2	0									
3203	3253		Record Only	8	50	320	200	70	0.5	.080	-	-	0.70	9	75	-	-									
3205	3255		Record Only	4	200	1300	150	370	0.5	.080	-	-	0.30	22	40	-	-									
4100	4150	PREMIUM FULL-TRACK Hyperbolic Face Laminated Cores	Record/Play	3	250	1500	80	200	0.16	.260	-	-	1.2	40	90	4.0	0									
4101	4151		Record Only	8	55	330	250	125	0.5	.260	-	-	0.8	24	100	-	-									
4102	-		Record/Play	6	100	600	100	125	0.16	.260	-	-	1.5	30	120	2.5	0									
4103	-		Record Only	7	10	60	500	6	0.5	.260	-	-	4.0	9	320	-	-									
4104	-		Record Only	8	30	190	200	22	0.5	.260	-	-	1.8	20	180	-	-									
-	4950	MINIATURE		Record/Play	6	40	250	150	125	0.16	.024	-	-	0.65	8	50	0.45	0								
5601	5651	PREMIUM 4-CHANNEL Hyperbolic Metal Face Laminated Cores	Record Only	8	50	320	220	150	0.5	.037	.071	50	0.6	7	60	-	-									
5602	5652		Record/Play	6	90	600	220	100	0.1	.037	.071	50	0.7	15	60	0.7	0									
5603	5653		Record/Play	3	370	2200	80	690	0.1	.037	.071	50	0.3	30	34	1.4	0									
5604	-		Record Only	7	12	75	500	55	0.5	.037	.071	50	2.0	4	110	-	-									
5701	5751	PREMIUM 3-CHANNEL Hyperbolic Metal Face Laminated Cores	Record/Play	3	340	2000	100	800	0.1	.043	.100	55	0.25	35	35	1.8	+1									
5702	5752		Record/Play	6	100	650	140	260	0.1	.043	.100	55	0.70	18	60	0.9	0									
5703	5753		Record Only	8	50	400	250	260	0.5	.043	.100	55	0.65	7.5	60	-	-									
5707	5757		Record/Play	5	200	1300	120	450	0.1	.043	.100	55	0.40	20	50	1.3	+1									
5710	-		Record Only	7	10	70	500	100	0.5	.043	.100	55	1.7	3.3	200	-	-									

APPLICATION NOTES:

1. High-impedance general-purpose record/play or playback-only head for vacuum-tube circuits.
2. High-impedance playback-only head for vacuum-tube circuits.
3. Medium-impedance record/play head for vacuum-tube or transistor circuits.
4. Medium-impedance record-only head for vacuum-tube circuits.

5. Medium-low-impedance record/play for transistor circuits.
6. Low-impedance record/play for transistor circuits.
7. Special low-impedance record-only for vacuum-tube or transistor circuits in duplicators and professional recorders.
8. Low-impedance record-only for vacuum-tube or transistor circuits.

TAPE HEAD SPECIFICATIONS

■ Erase Heads

See below for dimensions.



OPTIONAL LARGE CASE ('L' CASE) ERASE HEAD
Add "L" to standard No Mount model number as indicated in 'Optional Large Case' column.

NORTRONICS STANDARD MODEL NO.			HEAD DESCRIPTION	IMPEDANCE DESCRIPTION	1 KC INDUCTANCE		60 KC IMPEDANCE		OPERATING ERASE CURRENT*	DC RESISTANCE		60 KC OPERATING VOLTAGE
NO MOUNT	REAR MOUNT	OPTIONAL LARGE CASE			MHY	OHMS	MA	OHMS		OHMS	VOLT	
1400	1450	1400L	4-TRACK STEREO ERASE Full Metal Face	Hi	80	30,000	3-5	270	90-150			
1401	1451	1401L		Med.	10	2,800	10-15	40	28-42			
1402	1452	1402L		Lo	0.13	40	80-140	2	3-6			
2200	2250	2200L	2-TRACK STEREO ERASE Full Metal Face	Hi	80	25,000	4.5-7.0	205	100-150			
2201	2251	2201L		Med.	8	2,000	16-24	35	32-48			
2202	-	-		Lo	0.20	50	100-150	2	5-8			
2203	-	-	2-TRACK MONO ERASE Full Metal Face	Med.	4	800	20-25	17	20-30			
3600	3650	3600L		Hi	80	25,000	4.5-7.0	205	100-150			
3601	3651	3601L		Med.	8	2,000	16-24	35	32-48			
3602	-	-	FULL-TRACK MONO ERASE Full Metal Face	Lo	0.20	50	100-150	2	5-8			
3604	-	-		Med.	4	800	20-25	17	20-30			
4400	4450	4400L		Hi	40	12,000	10-15	88	100-150			
4401	4451	-	MINIATURE	Med.	3.6	1,000	32-48	25	32-48			
-	5350	-		Med.	5	1,200	28-42	38	32-48			

*For 60 db erasure of saturated tape.

■ "Combo" Heads

See below for dimensions.



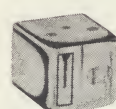
6000 THRU 6024



6025 THRU 6049



6100 THRU 6124



6125 THRU 6149

NORTRONICS MODEL NO.		HEAD DESCRIPTION	HEAD FUNCTION	EQUIVALENT HEAD SPECIFICATION REFERENCE	
NO MOUNT	REAR MOUNT				
6000	-	4-TRACK STEREO "COMBO" Metal Face	Erase, Record/Play	Record/Play 1201	Erase 1400
6001	-		Erase, Record Only	Record Only 1203	Erase 1400
6002	-		Erase, Record/Play	Record/Play 1201	Erase 1401
6003	-		Erase, Record/Play	Record/Play 1000	Erase 1402
6009	-		Erase, Record/Play	Record/Play 1009	Erase 1401
6025	-	4-TRACK MONO "COMBO" Metal Face Center Track	Erase, Record/Play	Record/Play 1000	Erase 1402
6026	-		Erase, Record/Play	Record/Play 1001	Erase 1401
6100	-	2-TRACK STEREO "COMBO" Metal Face	Erase, Record/Play	Record/Play 2001	Erase 2201
6127	-	2-TRACK MONO "COMBO" Metal Face Center Track	Erase, Record/Play	Record/Play 2601	Erase 3601

TYPICAL DIMENSIONS

1000 THRU 1049 1200 THRU 1249 1800 THRU 1849 2000 THRU 2049 2600 THRU 2649 4100 THRU 4149 5600 THRU 5649 5700 THRU 5749 6000 THRU 6049 6100 THRU 6149	1050 THRU 1099 1250 THRU 1299 1850 THRU 1899 2050 THRU 2099 4150 THRU 4199 5650 THRU 5699 5750 THRU 5799	3000 THRU 3049 3100 THRU 3149 3200 THRU 3249	1400 THRU 1449 2200 THRU 2249 3600 THRU 3649 4400 THRU 4449	1450 THRU 1499 2250 THRU 2299 3650 THRU 3699 4450 THRU 4499
		3050 THRU 3099 3250 THRU 3299	"L" CASE ERASE	4950 THRU 4999 5350 THRU 5399

MOUNTING STYLES



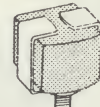
NO MOUNT



REAR MOUNT



SIDE MOUNT



BASE MOUNT

QK-18 adapts all standard No Mount Erase Heads to Side Mount.

QK-19 adapts all standard No Mount Erase Heads to Base Mount.

QK-20 adapts 3000 thru 3049, 3100 thru 3149, and 3200 thru 3249 No Mount R/P Heads and Record Only Heads to Side Mount.

QK-21 adapts 3000 thru 3049, 3100 thru 3149, and 3200 thru 3249 No Mount R/P Heads and Record Only Heads to Base Mount.

QK-38 adapts all other No Mount R/P Heads, Record Only Heads, and Combo Heads to Side Mount.

QK-66 adapts all other No Mount R/P Heads, Record Only Heads, and Combo Heads to Base Mount.

All specifications subject to change without notice.

AT-100 AZIMUTH AND AMPLIFIER ALIGNMENT TAPE



A 7.5 IPS Full Track master professional tape. It contains frequencies from 40 to 10,000 cycles for checking azimuth and equalization Full instructions recorded on tape.

Specifications for the Nortronics 8000 series (Professional Series) of magnetic tape heads are listed in form No. 7222.

CROSS REFERENCE TABLE FOR NORTRONICS HEADS

ORIGINAL DISTRIBUTOR HEAD NUMBER	CURRENT DISTRIBUTOR HEAD NUMBER	OPTIONAL AND INTERCHANGEABLE DISTRIBUTOR NO.	INDUCTANCE WHY "R" HAS RECORD GAP "F" HAS 50 U-IN. GAP	CURRENT O.E.M. EQUIVALENT MODEL NUMBER	ORIGINAL O.E.M. MODEL NUMBER	ALTERNATE AND CURRENT O.E.M. MODEL NUMBER	OBSOLETE AND DISCONTINUED MODEL NUMBERS
4-TRACK STEREO RECORD/PLAY AND RECORD ONLY							
1000	1000	1200	800	B2Q2K	CSQ2K	PB2Q2K	TLB2, TLD-L1
1001	1001	1201	400	B2Q7K	CSQ7K	PB2Q7K	TLB7, TLB-7K
1002	1002	1202	100	B2Q4K	CSQ4K	PB2Q4K	TLB4, TLB4K
1003		1203	50R		CSQ4R	PB2Q4R	TLB4R
1004	1000	1200	800	B2Q2K	CSQ1K	PB2Q2K	TLB1K, TLB1
1005		1205	200R		CSQ7R	PB2Q7R	TLB7R
1008			120	B2Q6N2			
1009	1009		500	B2Q2N2			
1100	1200	1000	800	PB2Q2K	ASQ2K	B2Q2K	
1101	1201	1001	400	PB2Q7K	ASQ7K	B2Q7K	
1102	1202	1002	100	PB2Q4K	ASQ4K	B2Q4K	
1103	1203		50R	PB2Q4R	ASQ4R		
1104	1200	1000	800	PB2Q2K	ASQ1K	B2Q2K	
1105	1205		200R	PB2Q7R	ASQ7R		
1106	1210		10R	PB2Q8R	ASQ23R		
1107	1207		200	PB2Q6K	ASQ6K		
1200	1200	1000	800	PB2Q2K	ASQ2K	B2Q2K	TLB2, CSQ2K
1201	1201	1001	400	PB2Q7K	ASQ7K	B2Q7K	TLB7, CSQ7K
1202	1202	1002	100	PB2Q4K	ASQ4K	B2Q4K	TLB4, CSQ4K
1203	1203		50R	PB2Q4R	ASQ4R		TLB4R, CSQ4R
1205	1205		200R	PB2Q7R	ASQ7K		TLB7R, CSQ7R
1207	1207		200	PB2Q6K	ASQ6K	B2Q6K	CSQ6K
1210	1210		10R	PB2Q8R	ASQ23R		
1221	1221	1201	450F	PB2Q7F		PB2Q7K	
2-TRACK STEREO RECORD/PLAY AND RECORD ONLY							
1800	1800	2000	800	B2H2K	TLA3L	PB2H2K	TLDS3, TLDLH3
1801	1801	2001	400	B2H7K	TLA4L	PB2H7K	
1802	1802	2002	100	B2H4K	TLA5L	PB2H4K	
1803	2003		50R		TLA5R	PB2H4R	
1900	2000	1800	800	PB2H2K	TLA3L	B2H2K	
1901	2001	1801	400	PB2H7K	TLA4L	B2H7K	
1902	2002	1802	100	PB2H4K	TLA5L	B2H4K	
1903	2003		50R	PB2H4R	TLA5R		
1904	2010		10R	PB2H8R	TLA2R		
2000	2000	1800	800	PB2H2K		B2H2K	
2001	2001	1801	400	PB2H7K		B2H7K	
2002	2002	1802	100	PB2H4K		B2H4K	
2003	2003		50R	PB2H4R			
2007	2007		200	PB2H6K		B2H6K	
2010	2010		10R	PB2H8R			
2021	2021	2001	450F	PB2H7F		PB2H7K	
2047	2047			PB2H47K	TLA54L		
2-TRACK MONO RECORD/PLAY AND RECORD ONLY							
2600	2600	3200*	800	PB1HY2K	SLA3L	PG1H2K*	SLA3L
2601	2601	3201*	400	PB1HY7K	SLA4L	PG1H7K*	SLA4L
2602	2602	3202*	100	PB1HY4K	SLA5L	PG1H4K*	SLA5L
2603	2603	3203*	50R	PB1HY4R	SLA5R	PG1H4R*	SLA5R
2610	2610		10R	PB1HY8R	SLA2R		
2700	2600	3200*	800	PB1HY2K	SLA3L	PG1H2K*	
2701	2601	3201*	400	PB1HY7K	SLA4L	PG1H7K*	
2702	2602	3202*	100	PB1HY4K	SLA5L	PG1H4K*	
2703	2603	3203*	50R	PB1HY4R	SLA5R	PG1H4R*	
2704	2610		10R	PB1HY8R	SLA2R		
3000	3000	3200	800	G1H2K	SL51L	PG1H2K	SL52L
3001	3001	3201	400	G1H7K	SL53L	PG1H7K	
3002	3002	3202	100	G1H4K	SL54L	PG1H4K	
3100	3100		1000	GMH1L	GMH1L	G1HY2K	SCS2L, SCS1L
3101	3101		400	GMH3L	GMH3L	G1HY7K	SCS3L
3200	3200	3000	800	PG1H2K	SLA3L	G1H2K	
3201	3201	3001	400	PG1H7K	SLA4L	G1H7K	
3202	3202	3002	100	PG1H4K	SLA5L	G1H4K	
3203	3203		50R	PG1H4R	SLA5R		
3205	3205		200R	PG1H7R	SLA4R		
FULL-TRACK RECORD/PLAY AND RECORD ONLY							
4000	4100		250	SLF3L		SLFH3L	
4001	4101		50R	SLF4R		SLFH4R	
4002	4102		100	SLF4L		SLFH4L	
4100	4100		250	SLFH3L	SLFH3L	SLF3L	
4101	4101		50R	SLFH4R	SLFH4R	SLF4R	
4102	4102		100	SLFH4L	SLFH4L	SLF4L	
4103			10R	SLFH7R16	SLFH7R		
4-CHANNEL RECORD/PLAY AND RECORD ONLY							
5600	5602		90	BQQ4K		BQQ4L	
5601	5601		50R	BQQ4R			
5602	5602		90	BQQ4K			
5603	5603		360	BQQ3K			
5604	5604		12R	BQQ23R			
3-CHANNEL RECORD/PLAY AND RECORD ONLY							
5701	5701		400	PB3Q7K			
5702	5702		100	PB3Q4K			
5703	5703		50R	PB3Q4R			
5707	5707		200	PB3Q6K			
5710	5710		10R	PB3Q8R			

ORIGINAL DISTRIBUTOR HEAD NUMBER	CURRENT DISTRIBUTOR HEAD NUMBER	ERASE VOLTAGE 60 KC	R/P INDUCTANCE WHY "R" HAS RECORD GAP	CURRENT O.E.M. EQUIVALENT MODEL NUMBER	ORIGINAL O.E.M. MODEL NUMBER	ALTERNATE AND CURRENT O.E.M. MODEL NUMBER	OBSOLETE AND DISCONTINUED MODEL NUMBER
4-TRACK STEREO COMBO							
6000	6000	115V	400	PA2Q17K			
6001	6001	115V	50R	PA2Q14R			
6002	6002	40V	400	PA2Q47K			
6003	6003	6V	800	A2Q22K			
6004	6004	40V	50R	PA2Q44R			
6005	6005	40V	200	VA2Q46K			
6009	6009	40V	800	A2Q42N2			
4-TRACK MONO COMBO							
6025	6025	6V	800	A1QC22K			
6026	6026	40V	400	A1QC47K			
2-TRACK STEREO COMBO							
6100	6100	40V	400	PA2H47K			
6101	6101	40V	50R	PA2H44R			
2-TRACK MONO COMBO							
6125	6125	115V	1200	A1HC11K			
6126	6126	40V	50R	PA1HC44R			
6127	6127	40V	400	PA1HC47K			
6128	6128	40V	200	VA1HC46K			

SMALL CASE DISTRIBUTOR HEAD NUMBER	SPECIAL LARGE CASE DISTRIBUTOR HEAD NUMBER	ERASE VOLTAGE 60 KC	SMALL CASE O.E.M. NUMBER **ADD "N9"	LARGE CASE O.E.M. MODEL NUMBER	OBSOLETE AND DISCONTINUED MODEL NUMBER
4-TRACK STEREO ERASE					
1400	1400L	115V	SEQ1**	SEQ1	SE50-1
1401	1401L	40V	SEQ4**	SEQ4	SE50-4
1402	1402L	6V	SEQ2**	SEQ2	SE50-2
1403		25V	SEQ9**	SEQ9	
2-TRACK STEREO ERASE					
2200	2200L	115V	SEH1**	SEH1	SE100-2
2201	2201L	40V	SEH4**	SEH4	SE100-4
2202	2202L	6V	SEH2**	SEH2	
2203		25V	SEH9**	SEH9	
2-TRACK MONO ERASE					
3600	3600L	115V	MEH1**	MEH1	ME100-2
3601	3601L	40V	MEH4**	MEH4	ME100-4
3602	3602L	6V	MEH2**	MEH2	
FULL TRACK ERASE					
4400	4400L	115V	MEF1**	MEF1	
4401	4401L	40V	MEF4**	MEF4	

PREMIUM HEADS

OBSOLETE HEADS

AVAILABLE ONLY IN NO MOUNT STYLE

ALL DISTRIBUTOR HEADS LISTED ARE NO MOUNT STYLES.

ALL O.E.M. HEADS LISTED ARE THE BASIC O.E.M. HEAD NOMENCLATURE.

O.E.M. HEAD NUMBERS	DISTRIBUTOR HEAD NUMBERS
NO MOUNT HEADS	
"-N" suffix designates No Mount (see exception **).	See above.
REAR MOUNT HEADS	
"-R" suffix designates Rear Mount.	Add 50 to No Mount Head number. Example: Head No. 1000 becomes 1050; 1234 becomes 1284.
SIDE MOUNT HEADS	
"-S" suffix designates Side Mount.	Requires Quik-Kit (see table of mounting styles - page 3).
BASE MOUNT HEADS	
"-B" suffix designates Base Mount.	Requires Quik-Kit (see table of mounting styles - page 3).

*ELECTRICALLY IDENTICAL BUT DIFFERENT SIZE CASE. MAY BE USED AS REAR MOUNT WHEN APPLICABLE.

**ADD "-N9" TO DESIGNATE NO MOUNT.